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THE MODERN CENTRAL STATION.

Elsewhere in our pages will be found a full account of the present condition of the great Quarry Street station of the Commonwealth Edison Company of Chicago, of which there has been previous notice in our columns. The article is too rich in details to summarize and will repay careful study as showing the evolution of the great modern power station. Its importance to the art lies not so much in its being a very big station, which it is, or a very well planned station, which it also is, but in its being the manifestation of very large ideals in central-station practice and exemplifying in a very remarkable way the bigger concepts and the wider view of central-station practice. The Commonwealth Edison Company has for some years been a leader in many things, but in nothing more conspicuously than in the grasp of the larger electrical situation as it exists in the beginning of this the twentieth century. It is a notable thing even in these days of big stations to find a new station rising to 84,000 kw capacity in six gigantic units. It is a much more important thing to realize that still another station, several miles distant, of 120,000 kw is under construction, and a third alongside it of equal rating is already planned. These two colossal stations will have 20,000-kw turbo-generators as the units, and the first pair of these is expected to be in service before the close of the year now beginning.

The maximum load on the Commonwealth Edison plant last year was 182,600 kw, and the plans for larger load are now being carried out so successfully that the chances are good for load commensurate with the capacity of the new stations by the time their generators are ready to turn over. A great fundamental principle back of this huge development is that the electric central stations of a great city should be planned to take care of all the power output that the city requires for all the various purposes in which power is used, and that these stations and the distributing system should be so skilfully and economically planned that this power load must by economic necessity come to rely upon them. The view is a logical one and it has been consistently followed in the development of the Chicago central stations. The end has already justified the undertaking. It is not the lighting of a big city with incidental motor service that has been the ideal of the creators of the Commonwealth Edison Company, but rather the acquisition of the entire electric service of a great territory not limited by even the city limits, nor confined to any few classes of service. One of the interesting features of the situation is that the time has evidently come when the gathering under a single roof of the generating equipment of a great city has ceased to be a logical procedure, when the territory served has become so huge and the size of the individual plants so great that aggregation is an inconvenience and a loss rather than an advantage. The stations of the past have generally been of such size that there could be economic gain in increase of size. The time has evidently now come when the individual plants

have already reached an output so great that further increase would make no material decrease of costs, and when it is of more importance to locate the next great plant in a position advantageous for the distribution as a whole than to have it adjacent to a previous plant. The time has come when great central-station properties are looked on as permanent, to be built up with the future in view and to be made ready to meet its requirements. It is this point of view and the full realization of the enormous possibility of electrical load with which coming decades are fraught that gives to the plant here considered its vital importance.

THE WORK OF THE REICHSANSTALT IN 1909.

As recently noted in the Digest, a synopsis of the report of the Physikalisch Technische Reichsanstalt, at Charlottenburg, has recently appeared in *Engineering*. The organization of the Reichsanstalt is dual, one part being devoted to physical and the other to technical or applied physical investigations. At times the two sets of investigations necessarily overlap, but the two official reports are kept separate in the same volume. In the department of photometry much attention has been paid to life tests of metallic-filament lamps. In the photometry of carbon-filament lamps the rotation of the lamps is not recommended, because at the speed of 180 r.p.m., necessary for obtaining a flickerless photometric illumination, the filaments are apt to be distorted by centrifugal force. With ordinary metallic filaments, however, employing many thread ascents and descents with correspondingly numerous positions of luminous symmetry in the horizontal plane, a much lower speed of rotation may be used advantageously. It is interesting to note that for a year past a tax has been paid on illumination in Germany, and that in the case of glow lamps this tax is levied on the watt consumption. This brings to memory the war tax which at one time was levied in England on windows and window glass and which had a distinct influence on the architecture of the period. The tax on light in Germany is not a heavy one, but it manifestly does not serve as a stimulus or incentive to the electric lighting industry. It would be interesting to know what the tax would amount to on some of our city electric signs, to say nothing of indoor illumination. In the department of magnetics an interesting fact is mentioned concerning certain samples of pure electrolytic iron. When deprived of occluded hydrogen by being heated in a vacuum these samples are said to lose almost all of their coercitive force, so that an iron free from hysteresis loss may finally be produced. It is very remarkable that a substance like hydrogen scattered through the mass of iron sheets should be able to affect the hysteresis, and the fact may have important potential practical bearings.

One cannot read the list of researches contained in the report, some of which are of a most practical character, without recognizing the enormous importance of the Reichsanstalt to the technical and manufacturing industries of Germany. Not only are manufacturers able readily and inexpensively to obtain certificates of reliability on all the material they buy and all the material they sell, but they are also able to keep themselves informed, through the work of the Reichsanstalt, on the latest developments in every line of production. Moreover, when difficulties occur with new processes or new lines of development they can often obtain a helping hand from the Reichsanstalt, which can initiate such researches by trained experts if the results are judged to be of sufficient importance to the industry at large. It is, therefore, no exaggeration to say that the Reichsanstalt is the center and basis of German specialized industry. The value to Germany of an institution like the Reichsanstalt, or to this country of our Bureau of Standards at Washington, is enormous, and is not to be expressed merely in terms of money paid for services rendered. Over and above all money values lie the stimulus to increased and improved productivity, the national prestige based on accurate knowledge of the facts of construction and production, and the encouragement of the engineers.

COMMUTATOR SEGMENT VOLTAGE IN DIRECT-CURRENT MACHINES.

As is well known, by many years of experience, the commutator is the most sensitive element of a direct-current machine and the weakest link in its chain of operation. It is wonderful how little trouble commutators give in practice considering how easily they may be put out of order, either mechanically or electrically. As a general rule all commutators spark at their brushes under normal loads. In most cases the sparking is insignificantly small, and in some cases it is almost microscopically small. It is only when the sparking exceeds a certain limit that it becomes serious and objectionable. Sparking may be considered serious (1) when it makes the commutator hot; (2) when it erodes or consumes either the commutator or brushes at an undue rate; and (3) when it approaches the limit at which an arc or flash-over on the commutator will occur between the brushes of opposite polarity. A machine may operate satisfactorily at its commutator under normal conditions, but may have so little margin of sparklessness that a slight accidental disturbance in the electric system, such as a momentary overvoltage or a momentary overload may cause the commutator to flash over, short-circuiting the mains, opening circuit-breakers and possibly injuring the machine. The theory of the commutator and its action is very complicated, and in its refinements exceeds the capabilities of modern analysis. But a working theory has been evolved after a great deal of experimental research carried on by a number of leaders in dynamo design.

One of the criteria of good commutation is found in the value of the average voltage between adjacent commutator segments under working conditions. If this segment voltage reaches a certain limit there will be a tendency to spark seriously; whereas, if the segment voltage is always kept well below this limit, quiet commutation may be assured. An article on the subject of segment voltage and its approximate measurement, by Mr. Theodore Hoock, has recently appeared in the *Elektrotechnische Zeitschrift*, as abstracted in the Digest. It is pointed out in this article that practical values for the segment voltage lie between 12 volts and 25 volts, and that it is ordinarily undesirable to exceed 30 volts or 35 volts. The ordinary shunt motor does not usually provide a greater speed range than 20 per cent on constant-potential mains. In such machines the segment voltage is readily capable of being kept within the required limits. When, however, a wide range

of speed variation is called for by shunt-field weakening the tendency for the segment voltage to rise becomes very marked. In fact, the practical solution of speed variation with shunt motors in the ratio of 1:4 or 1:6 called for the introduction of compensating field poles intermediate between the main field poles. The article indicates how these compensating poles materially assist in keeping down the segment voltage at weak fields and high speeds.

TUNGSTENS VS. WELSBACHS FOR STREET LIGHTING.

A very valuable paper by Mr. Haydn T. Harrison was recently abstracted in the Digest, but no mere abstract could do justice to the thoroughness of Mr. Harrison's discussion or to its direct practical bearing on street lighting here as well as in England. London has been the great experimental station for trying out new lamps and new methods of lighting. The various boroughs have taken up the street-lighting matter with comparatively free hands and have tried very striking experiments. One of these, to which Mr. Harrison pays special attention, is of peculiar value to American engineers on account of its involving the substitution of tungsten incandescent lamps for Welsbach lamps on a fairly considerable scale. The light actually given by Welsbach street lamps has been the subject of much debate. The question is really one of upkeep so far as the illumination is concerned and of the relative prices obtainable for gas and electricity. New Welsbach street lamps commonly show up admirably, but it is the misfortune of the Welsbach mantle that it suffers acutely from the conditions of burning met on the street and falls off so seriously after a comparatively short term of service that it becomes necessary to replace mantles frequently if the illumination is to be kept where it is supposed to be.

The change to which reference has been made is in the borough of St. Marylebone. As a preliminary to any serious effort at the change the average candle-power of the gas lamps was tested by taking 100 lamps at random and measuring them carefully. The result showed for the single-burner consuming 4.25 cu. ft. of gas per hour an average of 50 cp. The double mantles of similar character showed 76.6 cp. A second investigation, conducted by Mr. Harrison himself, showed an average of 45 cp for the single mantles and 76 for the double. These facts are similar to those which have been ascertained in like investigations in this country, although from the figures it would appear that the London gas lamps are rather better kept up on the whole than those in American cities. From these data the tungsten outfit was designed. Each single gas lamp was replaced by two 35-watt tungsten lamps and each double lamp by two 55-watt lamps. The existing lamp-posts and lanterns belonging to the Borough Council, and being in good condition, it was decided to retain them, which was done with the addition of a suitable reflector. The cost of conversion of the posts for their electric equipment was little less than $15 each, and 200 posts a week were thus changed, the total number of gas lamps displaced being nearly 2000. On the strength of the results by these the Council has decided to change the nearly 1400 remaining gas lanterns to electric as soon as possible.

Not only did the new arrangement give improved results in illumination, but it proved to be actually cheaper than the gas service it replaced. In some instances where the double mantles previously used had seemed insufficient two 80-watt tungsten lamps were used instead of two 55-watt, with a corresponding great increase in illumination. The posts are distributed in the more important thoroughfares at seventy-six to the mile, and at sixty-five to the mile in the less important streets, and under the new conditions the average minimum direct illumination is stated by Mr. Harrison to be for the main thoroughfares 0.15 ft.-candle and in the streets of lesser importance one-third to one-half of this amount. This is a very satisfactory degree of illumination from any point of view, and it well shows the admirable results that can be obtained by the intelligent use of tungsten lamps. This Marylebone experiment ought to go far toward demonstrating the desirability of similar changes elsewhere. The cost of energy for this particular service was figured low, about 3 cents per unit, and at this price tungsten lamps were materially cheaper than the gas lamps; but if one were to make the comparison, not on the basis of cost per lamp, but on the basis of effective illumination, gas would have made but a poor showing even had the price of electricity been considerably higher than it was.

DESIGN OF HIGH-TENSION CABLES.

Much attention has recently been given to the design and selection of high-tension cables by electrical engineers, owing to the increasing need for high-tension underground cable networks. Papers on the subject have been read before both the British and American Institutes of Electrical Engineers. Three types of high-tension cable are now well recognized, namely: (1) Simple, single-conductor cables, comprising a cylindrical central conductor, usually of copper, an external concentric conductor, frequently of lead, and a concentric cylindrical layer of insulating material between them; (2) multiple-conductor cables in which two or more insulated conductors are associated under a single external cylindrical sheath, and (3) graded cables containing a plurality of concentric insulating layers of different materials arranged in such order and thickness as to reduce the intensity of the dielectric stress in the cable. It is now well understood that the intensity of the dielectric stress tends to a maximum at the inner wall of any cylindrical insulating layer and increases with the curvature, so that it is greater over a thin wire than over a thick wire, other conditions remaining the same. Up to 10 kilovolts of effective working stress between conductor and sheath the design of a single cable offers little difficulty, but troubles commence when a 20-kv cable is sought, and they multiply when a 40-kv cable is desired. The cost of such high-tension cables rises rapidly above the 10-kv limit.

An article on the elementary design of ungraded cables, by Dr. Paul Humann, has recently appeared in the *Elektrotechnische Zeitschrift* and is abstracted in the Digest. It gives the well-known theory of the dielectric strength of these cables in a slightly different form from that generally employed. In particular, it presents curves of the cable diameters for given

tensions and conductor radii leading to the selection of a cable of minimum total cost for a given service. It would seem as though high-tension cables must be used to an increasing extent in cities, and there is a great demand for some fairly cheap insulating material of high dielectric strength, mechanical elasticity and chemical stability. Rubber is the best material known at present, but the price of this is very high. Varnished cambric and paper come next for consideration, but it should be possible to find a new material for the purpose as good as or even better than rubber. Curiously enough, nearly all the solids of high insulativity are rigid and non-elastic substances, such as sulphur, porcelain, glass and shellac. It has even been suggested that the property of insulativity depends upon, or is at least associated with, mechanical rigidity and brittleness; but the fact that rubber is both one of the best insulators known and also one of the most flexible of solids suggests the possibility of discovering artificial substitutes combining both qualities.

ELECTRICAL GROWTH IN 1910.

In no sense can 1910 be regarded as a year of great and spectacular activity in the industrial field; in fact, as the year closes the iron and steel trade might be said to be at a minimum of productive effort, with consequent severe restriction in other lines. The railroads have limited their purchases; no great enterprise, save Panama perhaps, has focused consumption or stimulated manufacturers; while even now capital is extremely cautious and slow as to its commitments in big "building for the future." Yet, on the whole, 1910 was not a bad year; in many respects it was a good year, and all the electrical industries enjoyed a steady advance much more sound and healthy than marked the notable expansion up to four or five years ago. It would be interesting, if it were possible, to know how far the electrical growth of these days is due specifically to the development from within each industry and how far it is due to supersession by other methods. For example, in street-railway work electricity now knows no rivalry, but the electric light still burns brighter every year because of the competition it meets and engenders. The electric motor is making good, but has many a rival among other powers. As for electric heating and cooking, it is simply marvelous that the art grows as it does in face of competition with cheapening gas.

	1909.	1910.
Electrical apparatus made	$275,000,000	$300,000,000
Electric railway earnings	475,000,000	520,000,000
Central-station sale of energy, etc.	250,000,000	300,000,000
Telephone earnings	250,000,000	275,000,000
Telegraph earnings	60,000,000	65,000,000
Isolated light and power plant earnings	75,000,000	100,000,000
Miscellaneous electric service	50,000,000	75,000,000
	$1,435,000,000	$1,635,000,000

It is usual for this journal to present annually its estimate of the public expenditure for electricity and electrical services. More often than not the figures are closely confirmed by census statistics and other data, but it is possible to go astray, and the table above should be taken only as an estimate of what are likely to be the approximate sums, bearing in mind that up to the beginning of 1908 the actual figures were available.

With regard to these figures it may be said that in a general way the growth of electricity is at the rate of about 20 per cent per annum over a period now reaching twenty-five years. It does not seem plausible that such a rate can be maintained, and, as the figures bulk up, it is most natural to look for a decline in the rate. Yet it is the fact that a great many electrical properties during 1910 show rates above 20 per cent, and these, too, the largest utilities. In the above table the gain in electrical manufacture has been taken at about 10 per cent; in electric railways at 10 per cent, which may be slightly low; in central station work at 20 per cent, which is about right; in telephony, nearly 20 per cent; in telegraphy, about 7 per cent; in isolated plant service, nearly 30 per cent, which may be excessive, but includes a lot of big power work, mines, battleships, etc.; in miscellaneous service, 50 per cent, which also may be high, but is likely to be correct. In other words, the largest single item of gain is taken at a low rate, and this would offset any excess in the smaller gains assumed at a higher rate. The progress in electrometallurgy and chemistry must not be overlooked; the advances made by the electric vehicle must not be forgotten; and there are a dozen or score of minor uses hardly dreamt of a year ago. On the whole, the *Electrical World* feels that it can stand by the total estimate given above, and is rather inclined to raise it to $1,750,000,000. But it is best to be on the safe side.

ELECTRIC LIGHTING.

It is pleasant to be able to record very material progress in electric lighting. To begin with, the material of lighting has been considerably improved. The tungsten lamp has, from the general experience of the central stations using it, been very substantially improved in quality as respects mechanical strength, an improvement in which the wire-drawn filament is beginning to play a considerable part. The result has been a very gratifying decrease in the breakage of lamps during shipment and in early burn-outs. It is hard to say from the data at hand whether the lamp shows much increase in average life, but the indications are rather favorable than otherwise. The normal standard efficiency has not been changed, nor does it seem likely to be. There has been, however, a very considerable change in the size of units available. The larger tungsten lamps of 150 watts, 250 watts, 300 watts and 400 watts are coming into use with very good results, particularly the two first sizes mentioned. A year ago engineers were going rather slowly in recommending these larger units, while now they do so without much hesitation. At the other end of the scale it is unfortunate that lamps taking as little as 15 watts and 20 watts at the ordinary voltage are being urged on central stations and consumers that otherwise would be fully content with the 25-watt and 40-watt units, which, if allowed to follow a natural course, would become the standards for interior illumination.

The tungsten lamps of voltage lower than 110, including the small, low-voltage sign lamps, are making some impression on special lines of lighting. The Hartford experiment, to which we have referred several times this year, seems to show the applicability of such small-voltage units to domestic lighting under conditions not generally considered altogether favor-

able. The reversion toward contract rates for these special classes of service, as shown in Hartford, and since then in a number of other places, is a very interesting development of high-efficiency lamp practice. The preliminary reports of this kind of service are on the whole rather encouraging than otherwise, and it may be that the combination of lower generating costs and increased lamp efficiency will tend to produce large increase of this class of central-station load. The electric sign business, which of late has been so considerable an item in the work of some central stations, seems to show no signs of declining. On the contrary, it seems to have come to stay, barring misuse esthetically that would lead to a reaction.

In street-lighting work there has been a very conspicuous movement toward more light and better light. This has been materially helped forward by the general use of the series tungsten lamps and the improvements in the types of arc now available for first-class lighting. The magnetite arc in the higher powers has made a strong impression on the art, and in the larger cities there are as well tendencies toward the installation of powerful flaming arcs for specially important situations. A good deal of recent progress can be put to the credit of the activity of merchants' associations, which have taken up the work of street illumination where the city has left it and have produced results, sometimes, it is true, rather flamboyant, but on the whole setting an example of first-class lighting that cannot fail to lead to better things. The luminous and flame arc in general have been very materially improved. They are not yet perfect, for the problems of lamp ventilation are very grave ones, and on lamp ventilation depends the final results attainable with these arcs, differing as they do widely from carbon arcs in that the products of combustion are solid instead of gaseous. The ordinary inclosed carbon arc must now be classed as obsolescent, and the production of the present large incandescent tungsten units will hasten its path toward oblivion, although it will probably hang on for a considerable period, just as the open arc has here and there survived even to the present time. But it must be admitted that the carbon arc has seen its best days, and a first-class luminous arc for alternating current would soon push most of the carbon arcs out of service. It is greatly to be regretted that the titanium arc for alternating current has fallen upon evil days and is no longer being installed to any considerable extent. It was a light of great promise on account of its admirable efficiency, and in some new modification may not improbably take a new lease of life. Another line of recent progress has been in the intensified carbon arc, of which the use for indoor lighting has very greatly increased during the past year. It seems satisfactorily to meet the color difficulty left outstanding by even the best incandescent lamps.

No new illuminants of any sensational characteristics have appeared during the year. The mercury arc and the Nernst lamp have been pursuing the even tenor of their way, the former in particular having made large inroads in the lighting of garages and industrial establishments. It is interesting to note here that the effect on the eye of the mercury-arc rays is not only harmless, notwithstanding early suspicion to the contrary, but workers under such light believe that it produces a beneficial effect on the eye even to such an extent as to warrant its being classed as a curative agent. From the central-station point of view the year has been a rather encouraging one, in spite of periods of dulness, and on the whole 1910 can be reported as a year of highly satisfactory progress in lighting matters.

ELECTROTECHNICAL PROGRESS IN 1910.

Electrical engineering is now so thoroughly incorporated with other branches of engineering that its advance is also a measure of the advance in engineering as a whole. For example, the largest single piece of engineering work in course of execution at the present time is that which is destined to sever the continents of North and South America, namely, the Panama Canal. Electrical engineering is to play a very considerable part in the operation of this canal. Similarly, in every important branch of engineering work electricity is continually assuming a more prominent share. On the other hand, electrical engineering is spreading in so many directions that no engineer can be familiar with all of its fields. Electrical engineers are specializing more and more. In fact, it may soon be necessary for students of electrical engineering to specialize before leaving the college or technical school. Specialization in electrical training, which has already commenced, though justifiable from the industrial standpoint, narrows the lif opportunities of the engineer and threatens in time to detract from the standing of the profession at large with the public. During the past year very substantial electrotechnical progress has been witnessed. The central stations have tended to deliver larger powers with larger units than heretofore and have also tended to higher voltages. We now have generator units of 15 megawatts and the limit of capacity in a single unit is not yet reached. Improvements have also been made in transmission-line insulation for high voltage, so that the line insulator is ceasing to become the weakest link in the chain of a long-distance power-transmission system.

A notable event in the electrotechnical year was the conference of the International Electrotechnical Commission at Brussels. The success of this conference augurs well for the success of the commission in its future meetings. A distinct start was made at Brussels in the direction of international electrotechnical terminology and the selection of equivalent technical terms from different languages. Another direction in which a start was made at Brussels was in the standardization of electrical machinery by the recommendation that all machines, generators and motors alike, should be rated in watts. Decided progress was also made at the conference toward a working international electrotechnical notation in the provisional adoption of eight symbols as a nucleus for a future list. In time it is to be hoped that, say, twenty or thirty of the most important electrotechnical symbols may be standardized internationally. A larger number would probably be too irksome and a smaller number would probably lead to much confusion in the comparative technical literatures of different countries. The Brussels conference also undertook a very important duty, namely, that of deciding upon an international standardization of the direction of rotation of vectors in alternating-current vector diagrams. This promises to be a great boon to the whole world of electrical engineering.

The year has also witnessed the successful laying of the first ocean cable loaded with Pupin coils. This was laid across the Straits of Dover and has enabled London to be brought into telephonic union with Paris. The achievement is not only in the design, manufacture and laying of loaded cables, but also in the design and predetermination of telephone circuits. Improvements have also been made in transoceanic wireless telegraphy, whereby a regular wireless telegraph service over the Atlantic Ocean has been established. Incidentally, improvements in telephone relays have contributed to this result by increasing the sensitiveness of the wireless-telegraph receiver.

A research made during the year at the Bureau of Standards has shown that the temperature coefficient of resistivity in copper is proportional to the electrical conductivity of the sample within the range of variation met with in good commercial copper. This relation places the conductivity and the resistivity temperature coefficient upon a parity in their practical importance to the electrical engineer who uses ordinarily good copper conductors, but, at the same time, simplifies the task of measurement by requiring only one of these two quantities to be measured. The year has also witnessed an important step in American electrotechnical literature toward international legibility. To the trained engineers of all countries save Great Britain our electrotechnical publications are to a considerable extent sealed books, because of the antiquated and complicated pound-foot-inch units of measurement in which they deal and which can only be deciphered internationally by reference to troublesome tables of equivalents. During the past year an editing rule has been adopted by the American Institute of Electrical Engineers, the American Electrochemical Society and the Illuminating Engineering Society to add international numerical values, in parentheses, after each English value in all publications. This plan not only brings our electrical engineers into closer touch with our confrères abroad, from whom, in many directions, we have much to learn, but it also supplies automatically a valuable check and confirmation on numerical valuations of all kinds.

THE CENTRAL STATION SITUATION.

During the past year nothing especially suggestive of comment has occurred in the general central-station field. The tungsten lamp continues gradually to displace the inefficient carbon filament, which latter would be much more rapidly becoming a curiosity of the past were it not for the serious question of station income involved in the change from the old to the new. As a means of competition with gas, the tungsten is in many places making amends for its intrinsic commercial defect as a meter accelerator, and in the street-lighting field is showing what it can accomplish for the central station when given a fair show. The period of transition from the carbon to the tungsten filament would have been far less painful and less strung out if the central station industry, upon the advent of the latter, had, as a body, made a determined and persistent effort to raise the standard candle-power unit to the level of the 40-watt tungsten. By so doing it would have been placed on terms of lighting equality with the mantle candle-power of the gas industry, and little or no resistance would have been encountered from consumers; for the whole history of economics has shown that people upon the cheapening of a necessity or convenience, instead of reducing their expenditure for it proportionately, simply use enough more to balance the cheapening. Furthermore, the substitution of the higher candle-power would not result in over-illumination, since the human eye does not recognize an upper limit of illumination until the intensity of daylight is approached. In greater intensity of illumination much more progress has been made in exterior than in interior lighting. The progress in this respect has been satisfactory where new contracts for street lighting have been made during the year; and central stations owe much to the enterprise of merchants' associations in educating the public to the advantages of better street lighting. Every special installation of this kind is an object-lesson for better lighting of all streets, and merchants should everywhere be encouraged to organize "downtown" lighting associations. The increasing use of the flame arc in street lighting will further forward the good cause; and it is gratifying to note that when incandescents are applied to street lighting they are of much higher candle-power than the one-time street carbon incandescent. "More light for the same money" is more than a slogan for central stations, for it also stands for the brighter illumination which should displace the past relative gloom of artificial lighting.

The rate question still continues to be the subject of wide discussion, and the "best" rate systems are becoming increasingly numerous. This multiplication of systems appears in part to spring from lack of real comprehension of the basic principles of rate-making, or perhaps it should be said of discrimination as to their relative weights. It is remarkable that few, if any, of proposed systems add anything to the theory of rate-making as laid down by Hopkinson in 1892, though this is rather a tribute to the genius of the scientist who became a central-station engineer than a criticism of the ability of those who have since taken up the subject. While it would be desirable to have a single rate-system of authoritative source, it now seems that it is by a process of cut-and-try that the outlines of a permanent system will finally be fixed; and that in any event local prejudice, personal opinion, legislation, ordinances, public utility rulings and other considerations will govern final accordance with an ideal system. Several interesting experiments with partial flat-rate systems will be watched with much interest, and particularly those designed especially for small residence service. Even the heterodoxy of flat rates could be borne if it introduced the electric light into the small residences from which central-station service has heretofore been barred, and which vastly outnumber in almost every community the number of houses at present using electric light.

The tendency appears to be increasing toward the consolidation of central station properties in syndicates of national scope, and the merging of numbers of small companies into a single one, supplying from a central generating plant the service formerly given by each of the component companies. Perhaps the greatest progress of the year has been in the application of the idea of "new business" organizations and in the increasing perfection of detail in such organizations of

older date. The growth of this development has been so rapid during the past few years that, from being the subject of reproach for weakness in business management, many of our more enterprising central stations rival in commercial methods old-established lines of business and in cases can even give pointers to the most up-to-date among these. The requirement of rational methods of accounting in the case of plants in States having public-service commissions has finally given to that important subject a serious status it formerly lacked, which change in spirit is doubtless partly due to the probable extension in the near future of public utility regulation, and this makes it a matter of good policy to get things into shipshape condition before the advent of the inquisitor. One undeniable boon which public-service commissions have conferred on plants coming under their supervision has been the requirement of a system of accounts which incidentally enables the central station to know the actual state of its business, to follow its progress intelligently, to discriminate between losing and profitable service, and to have facts on record that will enable formerly unsuspected loss to be turned into profit, if that be possible. Various matters relating to central-station details are treated under separate heads in the following pages. In general, the situation in its various aspects appears one full of promise for the enterprising central station.

PROGRESS IN ELECTRICAL SCIENCE.

Although it is quite possible, and indeed often happens, that during the space of a twelvemonth pure science in any given field may make very different progress from applied science, the one sometimes temporarily outstripping the other, yet in the long run the two are so closely connected that the progress of the one means the progress of the other. In the year just closed very satisfactory progress has been recorded in electrical science. The electronic theory has made notable strides through what seems to be the isolation of negative ions. Ordinarily, electrical workers do not deal with ions alone. When ions come, "they come not single spies, but in battalions." The single ion is believed to be so minute that about 1000 of them weigh collectively as much as an atom of hydrogen. Since the largest molecules of chemical substances are ultramicroscopically small, and the hydrogen atom must be a very small atom, the ion must be ultra-ultramicroscopic. Nevertheless, the electric forces capable of being developed by a single ion are relatively so strong that the addition of a single ion to a small mass of matter, such as a droplet of oil, is capable of changing the electrical properties of the mass in marked and easily recognized degree. In this sense the isolation of negative ions is believed to have been witnessed by more than one observer during the past year. This ionic negative charge is supposed to be the fundamental unit of negative electric charge. One can have multiples of this charge, but not subdivisions. A smaller charge than this fundamental unit is at present both inconceivable and unbelievable. Experiments have also been made tending to indicate that the positive ion may have been isolated. There is still much debate as to the existence and nature of positive ions. In this sense the old debate of the one-fluid versus the two-fluid theory of electricity has been resuscitated and given a new lease of life and energy in an entirely new sense that the original debaters would never have recognized.

Experimental researches have been continued with success in powerful magnetic fields and our knowledge concerning the magnetic properties of iron and iron alloys in these fields has been materially extended. Alternating magnetic fields have also been pushed to limits not previously explored and incidentally a perceptible physiological effect of such alternating fields upon the human senses has been announced. In the region of terrestrial magnetism much new material has been collected through the wandering cruises of the steamship *Carnegie*, that goes about to seek the dip and declination of the compass needle in all parts of Neptune's dominions. The modern steel ship is entirely unfitted for this work, and a large number of appreciable, but not very serious, discrepancies in the magnetic elements of the ocean charts have been brought to light in this way. Progress has also been made in deciphering the immense and complicated hieroglyphics of terrestrial magnetic observatory records by researches into the rate of propagation of magnetic storms. These magnetic storms are not only mysterious phenomena, but they also bring very manifest distresses to electric signaling over long distances, both wirelessly and by wires. Researches continued during the year into the properties of linear electric oscillators related to the aerials of wireless telegraphy have tended to confirm that particular previous theory of their action which defines the height of a single unloaded vertical wire with a good ground at the base as very nearly a quarter of the wavelength of emitted waves. There has been a good deal of debate over this question in the past. A recapitulation of the year's scientific records in electricity would not be complete without reference to the joint research of the National Laboratories of England, France, Germany and the United States, at the Bureau of Standards in Washington, over the internationally acceptable technique for the electrochemical equivalent of silver and the international value of the e.m.f. of the Weston cell. This joint research of scientific experts from the various national laboratories is an innovation of great importance that the past year may clearly claim as its own.

THE SMALLER CENTRAL STATION.

When it is recalled that of the 6000 central stations in this country more than 85 per cent are to be found serving communities of less than 5000 inhabitants the aggregate importance of the problems of the small electric-light company will be somewhat appreciated. In fighting the battles of competition with old illuminants, and educating the ultra-conservative public of these communities to the possibilities of electric-motor drive and heating appliances, the path of the small-town manager is beset with difficulties. But any one who has had an opportunity to study the smaller plants of this country, in whatever section, must be ready to testify that on the whole the future of electrical development in the small cities is in excellent hands. The electric-light manager of this character, we dare assert, will be found usually to be better informed, more progressive and public-spirited as a citizen, and a closer student of the details and advances of his complex business, from steam apparatus to customers' rates, than are any of the town's leading

bankers, merchants, contractors or other business men in their own older established occupations. Increasing factors in this progressive personnel are the young technical graduates, often town boys or sons of the local plant owners, who return from academic studies and industrial experience, bringing the best ideas of modern practice to the aid of the home plant.

During recent years the small central station has shared in the phenomenal growth observed everywhere in the electrical industry. The number of lighting customers has customarily grown far more rapidly than the town's population, and motor loads, electric irons and other day-service devices have come to the aid of twenty-four-hour operation. There are few towns provided with an electric-light plant which could not support a properly campaigned day service from among the local printing offices, grain elevators, shops and factories and home heating apparatus. When twenty-four-hour service has been begun few managers regret the move, in spite of the interval of increased cost at the outset. Such continuous service is made more economical by transmission combinations, extending the lines of the company out to serve neighboring communities. The success of such systems is attested by the increasing number of these interurban transmission lines, the generating company either doing its own distributing or wholesaling to a local company for distribution. Under equitable price agreement, both arrangements have been found mutually profitable to company and customer. Where such lines penetrate good farming country rural customers along the route are found to be good consumers of electricity.

As noted recently in these columns, a remarkable boom in isolated lighting systems with gas engine and battery has resulted from a well-directed campaign of advertising to farmers. Such isolated installations cost from $500 to $800, and provide electricity for lighting, and for driving pumps, churns, separators, cutters, saws, etc. The lesson of this isolated-lighting plant movement, from the central-station viewpoint, would seem to be that the farmer, now become our most prosperous class, is anxious to get the benefits of electric service and is willing to pay well for it. In many instances when such farms are not too remote from electric plants, it should be possible to induce the owners to invest nearly an equal amount in transmission lines and apparatus, a number clubbing together when possible, and so obtain unlimited electric service without the inherent drawbacks of isolated operation with storage battery and gasoline engine. This opportunity for the small-town central station is beginning to be worked out successfully in several Middle West farm communities, where the farm owners bear part or all of the pole-line expense.

Combinations of the electric-plant functions with ice-making, steam heating and water pumping have also proven successful additions to central-station operation on account of the interesting complementary relations between the demands of these classes of service. Plants operated at a loss in small towns as simple electric stations have been known to become dividend-paying properties after auxiliary ice-making or steam-heating was added to utilize waste products to advantage. Internal-combustion engines using gas and oil as fuel have also shown attractive performances in small units, rendering good central-station service in places where exhaust steam is not of value, or the special fuels employed are unusually plentiful or cheap. The steam turbine and exhaust steam turbine do not show their best economies of performance under the non-condensing conditions prevalent in the small central station, but new types of European steam engines are attracting attention in this country, from showing operating results that give increased expectancy to the reciprocating type of steam-power machinery. The purchase of steam from the boilers of some local manufacturing plant has been found a successful expedient in many small stations, avoiding the stand-by costs of keeping plant boilers in service during light day loads. The central stations can reciprocate after darkness, supplying lighting and motor service when it is desired to operate some department of the factory overtime.

Rates do not occupy the attention of the small-town manager to so great an extent as in the case of his co-worker in the larger cities. The rates of the successful small station must be simple to understand and involve a low minimum charge. The lower scale of household expense in small communities makes a large minimum seem prohibitive, and several successful operators have learned that by conceding this initial point they profit well from the increased business and heavy bills during other periods of the year. The average small-town resident is suspicious of a rate schedule so complicated that he cannot understand it. However, the flat rate is steadily giving way to metered service in the small places, as it did a decade ago in the larger cities. Controlling devices for limiting current demands are not so important in small towns where the lighting superintendent carries in his head the number of lamps in Widow Johnson's dining-room and the location of every electric iron in town.

The story of the tungsten lamp's advent with many small stations is sometimes one of 100 per cent increase in illumination and 33 per cent decrease in bills, but the ornamental tungsten street lighting, recently become so popular everywhere, has provided a brand-new outlet for central-station energy. Sometimes this service is paid for by the merchants, property owners or city, and being long-hour business is often the subject of a profitable contract. Sign lamps may make the streets of the humblest village attractive after dark. The central-station man also has the tungsten lamp to thank for the powerful weapon it provides him in competing with gasoline and gas incandescent-mantle lighting systems. The gasoline-lighting problem is doubtless one of the hardest situations the electric-light man is called upon to confront, but the over-thrifty owner usually returns to the electric company's service after a few months' experience with the dimming mantles, excessive gasoline consumpion and tremendous fire hazard surrounding every such plant.

ELECTRIC ENERGY TRANSMISSION.

From an engineering standpoint electric power transmission has, aside from the operation of the Hydroelectric Power Commission of Ontario, been taking the rest cure of late, so that while there has been a considerable amount of new construction within the year just closed it has evolved, save in minor details, and this chiefly on the hydraulic side, comparatively little of novelty. The fact is that the apparatus and methods are

just now pretty well standardized, which always implies a temporary cessation of improvement until the art takes a fresh start in perhaps some unexpected direction. There has been no increase in working voltage worth mentioning; the top figure of somewhere nearly 110,000 volts is maintained only in a very few plants, and the more ordinary figures of 50,000 to 70,000 are such as to call for little comment. In fact, we very much doubt whether the new constructions of the year show any material change in voltage as compared with the construction of last year. In fact, a plant actually working at 100,000 volts is at a point where, unless the necessary amount of energy to be transmitted is enormous or the distance is very great, ordinary mechanical considerations determine the size of the copper and further increase of voltage would mean taking considerable risks for very small gain in efficiency. Even in the few cases where the size of copper at 100,000 volts is such that considerable saving in cost would be secured by further rise of voltage, it still remains a question whether the extra insulation demanded would not in the long run cost more than the copper and whether, granting that the size of the copper could be reduced, it would not pay better to maintain the copper unreduced in total amount, but in the form of a duplicate line.

In general power-station design, granted the maintenance of any of the standard voltages, there is little occasion for novelty. In fact, for the ordinary design of a power station one could write something very like a prescription, given as symptoms the distance of transmission, the amount of energy, the available hydraulic head and the names of the bankers who underwrote the bonds. As the financial question is rather more often the amount of bonds that can be placed on the property than the determination of minimum fixed charges, the engineer has ordinarily comparatively little to do save pick out the necessary standard sizes and speeds of machines and select from suitable catalogs the largest amount of switchboard apparatus that his conscience will permit, since nothing makes a better appearance when the bondholders drop around than an elaborate and beautifully organized array of automatic switching apparatus. The brunt of the real work falls upon the unhappy constructing engineer, who has to stand as a buffer between the designing engineer and his backers, on the one hand, and a miscellaneous crew of contractors, on the other. It is small wonder, therefore, that the electric end of energy transmission is just now in a position of stable equilibrium and that the real engineering activity is most conspicuous in hydraulic work, of which the detailed operation—Heaven be praised!—cannot be conveniently standardized.

The most encouraging feature of electrical progress is the steady tendency toward the organization of large distributing networks, which, in the long run, must prove to be of great importance in the securing of cheap and reliable transmitted energy. Just how far even this will benefit the public, if the present tendency toward wholesaling energy is kept up, it is a little difficult to say. The natural and proper line of development is that pursued in some of the important Western networks, where a large territory is actually supplied practically at first hand from the transmitted energy. The normal process for a great electrical development is the constitution of what is virtually a single huge central-station organization covering a county or two instead of a town, and taking full advantage of all the resulting possibilities of efficient distribution. In fact, looking at the matter in the large way, the most useful and best-managed energy-transmission systems are those which have grown up around ordinary central-station practice. These matters aside, it seems that the line of progress marked out for the immediate future is rather the organization of efficient and widely ramifying networks than any particular change of methods and apparatus.

The situation with respect to electric energy distribution in many regions is very illogical. There are small stations scattered here and there working from steam or water, or both, and hydroelectric transmission companies wholesaling energy to some stations and to a few private consumers in the same territory. There ought to be instead a physical merger of the properties into one coherent network under one systematic management, organized not as a raft on which to float securities, but as a conservative corporation to derive its profits from the sale of electric energy. There is comparatively little need for any radical changes on the engineering side of the work until the organization of such networks requires changes of method in order to meet the requirements of larger and longer transmissions than are now common. At present the best engineering in electric energy transmission appears to be that being done by the Canadian Hydroelectric Commission and the Southern Power Company, accounts of whose work have appeared in these columns from time to time. There are no very long-distance enterprises at the moment in sight, and hence there has been no occasion for changes in practice. Even the larger projects of railway electrification with their accompanying beautiful problems in transmission seem to have for the present subsided.

THE ELECTRIC VEHICLE.

While during the past year the electric vehicle has experienced no boom, it has made substantial progress, particularly in the way of establishing a firm basis for future development. The ill-advised spurt of ten years ago left an evil effect which persisted beyond all reason; but the lingering suspicion as to the actual merit of the electric vehicle may now be said to have disappeared from the minds of all whose opinion is worth considering. An evidence of the revival of confidence is given by the support accorded by the leading central-station men of the country to the recently founded Electric Vehicle Association of America, which promises to be a most important factor in rapidly advancing the interests of storage-battery vehicular traction. As long as the full confidence of central-station men was withheld the cause was seriously handicapped, for the public could not be expected to take a serious interest in a proposition not meeting the full approval of the very men to whom it should appeal through the profit involved in the increased sale of electricity. Happily, this reluctance now appears finally overcome, and the association should find the central-station industry its strongest aid, as well as the most efficient agency, in the propaganda about to be started.

Through gradual improvement the transportable lead battery has been brought to a state justifying the claim that, with

ordinary care, it now amply fulfils the practical requirements for vehicular service; and the new alkali battery has in service sustained to a high degree the claims made for it. There are thus now two distinct types of transportable storage batteries to be confidently counted on in developing an electric vehicle industry which, in a few years, should take a place among the more important branches of electrical application. That such a prediction of large development is warranted is shown by what has been already accomplished in cities where intelligent and well-organized effort has been made toward advancing the electric vehicle. We need only point to the examples of Cleveland and Rochester, Toledo and Washington, and among small cities, of Rockford, Ill. The first stage appears to be the cultivation of the pleasure vehicle, and success had been met in this field by avoiding competition with the gasoline touring car and concentrating on the superiority of the electric vehicle for urban service. In time relay stations will enable the latter to compete with the gasoline car, but the idea of such competition should at present be kept in the background. While the field for the pleasure vehicle is one of great profit in itself, both to the manufacturer and to the central station, it is, so far as relates to large cities and great manufacturing centers, secondary to the opportunity for the electric wagon and truck. It is in this branch that the electric vehicle will finally meet its greatest development, though necessarily progress will at first be relatively slower than in the introduction of the pleasure vehicle owing to the revolutionary nature of a change affecting an industry for centuries hitched to the horse and with which much capital and a large army of labor are associated.

As the electric vehicle has now been brought to a high state of technical development and passed entirely beyond the experimental stage, and its widespread use appears only a matter of future commercial exploitation, attention will be more and more concentrated on matters of detail that in the development period are naturally passed over. In his presidential address before the Electric Vehicle Association of America Mr. W. H. Blood referred to some of these, including the standardization of voltages, chassis and size of batteries, and the desirability of co-operation with the gasoline vehicle industry in the standardization of tires and wheel tread. It would also seem to be desirable to come to some consensus of opinion as to the charge range of the pleasure vehicle and of standard capacities for the electric wagon and truck. The electric truck is free of limitations in its competition with other means of vehicular transportation, but the pleasure vehicle is at a disadvantage when a general comparison is made with the gasoline car owing to the unrestricted touring range of the latter. While the future will undoubtedly witness the establishment of more or less complete systems of relay station charging, and perhaps even the development of a system whereby the owner of a vehicle can at each stage of a trip exchange a depleted battery for one fully charged, for the present it would seem a matter of good policy to standardize electric vehicles on the basis of single-charge mileage range under normal conditions. The charge range of the present-day pleasure vehicle is amply sufficient for city and neighborhood service, and a frank rating on the basis of mileage will do no harm, but, on the contrary, should do good by rendering the electrical proposition entirely definite to the prospective user and dissociating it in his mind from the long-range gasoline competitor.

The immediate work of the association, however, is educational, and, with the large monetary resources at its command, the merits of the electric vehicle should this year become known as never before to the public. In such a campaign the central-station industry should be a valuable auxiliary, if it can generally be brought to see that the interests of the electric vehicle are closely allied with its own interests, and that working for an electric-vehicle load is just as sound in policy as working for increased lighting or motor load. We believe that central-station men recognize in general the opportunity, and that with sufficient encouragement the central station can be made the strongest factor in the commercial exploitation of the electric vehicle. The relation between the association and this agency of exploitation should be as direct as possible, and might extend to the supply for local use of advertising copy and the compilation for distribution to central stations of an electric vehicle commercial manual similar to the Electrical Solicitor's Handbook issued by the National Electric Light Association.

DEVELOPMENTS IN ELECTRICAL MACHINERY.

No new types of electrical machines were placed on the American market in 1910, but standard apparatus was built in sizes which would have been considered impracticable, if not impossible, a few years earlier. Generators ranging in rating from 10,000 kw to 15,000 kw for operation at speeds of from 300 r.p.m. to 750 r.p.m. and synchronous converters rated as high as 3000 kw were placed in service during the past year. A difficulty which was encountered in operating certain of the early high-speed turbo-generators was caused by the excessive current delivered by the machines on short-circuit. The force produced by the short-circuit current distorted the armature windings and in some cases destroyed the generators when the windings were not sufficiently protected. Bracing the armature coils against the core minimized the damage occasioned by a short-circuit but did not lessen the current reproduced in the armature circuit. The immediate cause for the excessive current was the small value of the local magnetic leakage reactance of the armature coils, in which very few turns were used because of the high rotative speed. A later development, which tended to minimize damage by limiting the short-circuit current, consisted in inserting reactance in series in the generator leads. This scheme has proved thoroughly effective, but the design of proper reactive devices has been no small problem. A still later development consisted in passing the load current from the generator into the primary circuit of an "insulating transformer," the secondary of which was connected to the load circuit. This transformer was designed with the amount of magnetic leakage required for protecting the generator under short-circuit. According to the latest development, the protecting transformer is a two-to-one auto-transformer having the desired amount of leakage reactance and operating at extremely high efficiency. The generator is wound to deliver its load at one-half of the circuit voltage, while the auto-transformer is wound in such a way that it

would be rated at one-half of the generator output if it were used as a one-to-one insulating transformer.

In the not far distant past, American engineers were discussing at great length the relative advantages of single-phase and three-phase transformers for polyphase service at a time when very few three-phase transformers were in use, and which type, in fact, was, in this country, distinctly non-orthodox. Conditions have so far changed that for the very large units the three-phase type may now be considered standard. Three-phase transformers are now being built in ratings as large as 14,000 kva, while 6000 kva is the rating of the largest single-phase unit thus far constructed. Although the standard high limit of transmission e.m.f. is still from 100,000 volts to 120,000 volts, yet an operating e.m.f. as high as 138,500 volts has been reached and testing transformers have been built for as high as 400,000 volts. In the transformer field an important improvement has been the increase in the maximum permissible size of self-cooling units from, say, the 800 kva of a few years ago to 2000 kva at the present time. This increase is attributable to the improved methods of causing the oil to circulate within the case and become exposed to the cooling effect of the exterior surface of extended area.

The polyphase induction motor remains the popular machine for general industrial service. Some departure from the earlier standard low-resistance, squirrel-cage form is to be noted in the increasing use of motors specially designed with reference to the service to be performed. Where formerly only so-called standard squirrel-cage motors would have been employed, use is now made of induction motors with coil-wound secondaries or with primaries arranged for multispeed operation. Few, indeed, are the services performed by the shunt-wound, direct-current motor in its various types that cannot be obtained by means of some form of the polyphase induction motor as now developed. Possibly the only exception is found in the adjustable-speed, direct-current motor, which has no successful rival in the polyphase induction type. A three-phase machine which offers inviting possibilities for development for adjustable-speed service is the polyphase commutator motor, which has not yet passed beyond the experimental stage in this country. It is not too much to look forward to the introduction of this type of machine in the near future. When that time arrives the highly successful variable-speed, constant-speed and adjustable-speed, direct-current motors will have worthy rivals in the single-phase commutator motor, the three-phase induction motor and the polyphase commutator motor.

INDUSTRIAL ELECTRIC POWER.

While there has been no shining installation of motors in industrial work in 1910 comparable with that laid down at Gary, Ind., in 1909, manufacturers report that the sale of small motors during the year has been larger in proportion to the total sales than ever before. That these motors have found their way to central-station circuits is evidenced by the increased earnings of electric light companies, which cannot be accounted for by any phenomenal increase in the number of incandescent lamps installed during the year. The movement toward the adoption of the electric motor as a source of power is very broad and far-reaching. Years of missionary work have had their effect and the universal experience is that one motor installation leads to another. It has been repeatedly shown that, taken on over-all merits and in detail, the electric motor drive not only equals but surpasses any other form of motive power. Heretofore the want of a well-defined plan of development for a load, which managers have now come to regard as their main business, has led to concentration on really casual work, because for the moment it appeared to be more profitable, certainly more showy, and in reality only added to the peak. For some unaccountable reason motor installations do not seem to leave great impressions on the minds of average solicitors. The motors usually lack human interest and are located in uninviting places; but these homely installations are continually grinding away and pouring income into the coffers of the electric light company. Just one taste of a good motor load is all the average manager needs to whet his appetite for more, and it is surprising to note how rapidly his vision broadens. Power customers no longer deal with men who are merely ordinary salesmen, good enough for selling a non-technical commodity, but unable to grasp clearly and point out just exactly where the motor surpasses an engine and why it does so. The supply of electricity is now regarded as being as much a business as the manufacture and sale of any other commodity, and the same business principles of development are being applied to it. Yet it is only within the last year or two that anything like a serious effort was made to push the use of electricity on commercial lines.

The first cost of electrical apparatus and machinery has always been a factor in the non-adoption of such apparatus in competition with gas and steam. Thoroughly technically and practically trained salesmen, animated by confident enthusiasm, have, however, largely overcome this objection by awakening interest in the mind of the manufacturer in the beneficial results to be obtained by motor drive and proving an actual saving possible. A minute study of the isolated plant problem, especially in the large cities, has revealed the fact that these are not so invulnerable to central-station attack as is generally supposed. Manufacturers of electrical apparatus with their well-equipped industrial engineering departments have done much to aid in the work of quickening the interest of the prospective buyer, and when working in conjunction with the central station the result is that complete and accurate information regarding the operating conditions of the particular plant is compiled and submitted to the heads of the firm, and these, being commercial men, realize the importance of cheap power, and, knowing the trend of future developments, make the best provision for the present. An unlimited amount of power available at any hour of the day or night by simply closing a switch is an advantage which cannot be overestimated. Where isolated plants are installed the generating equipment must almost equal the rating of the total motor installation, whereas the maximum demand on central station circuits for the entire installation is usually less than one-half the horse-power rating, and it is the maximum demand which influences rates. Contractors engaged in general municipal and other undertakings are also relying more and more upon electricity as a motive power, and the use of energy by them during the past year has been very great in some localities.

ELECTRIC HEATING.

The number of electrically heated devices in use at the present time is much greater than is generally supposed. The day for the general adoption of electricity for cooking seems much nearer now than it was a year ago, and with a satisfactory rate and improved apparatus substantial progress is not far distant. Among the more intelligent electric cooking utensils have found wide adoption despite the handicaps of a high rate. But the electrically heated devices do not fare so well in the hands of servants, and as in central-station practice the chances for waste are greatest in the boiler-room, so in domestic work the place for greatest losses is in the kitchen. It is, of course, necessary to get the attention of the mistress of the house in order to introduce electric cooking apparatus, but its reputation is made or unmade by the cook. This is the servant problem brought home to the central station. The 6-lb. electric flatiron is still the most popular heating device on the market. The manufacturers of these devices are now offering an electrical duplicate of every iron on the market at present heated by gas, coal or any other means. Next to the flatiron the electric toaster enjoys the widest sale, and the indications point to energetic toaster campaigns during the coming year. The toaster, like the flatiron, costs so little to operate and contributes so much to personal comfort and convenience that it is its own best advertisement. Strange as it may seem, the electric heating pad is the third most popular device and only because the manufacturer in this case, as in the two preceding instances, has produced an article which meets practical requirements. The use of percolators, chafing dishes, plate warmers and numerous other dining-room fixtures has increased amazingly and it is to these convenient, although small energy-consuming, devices that much of the popularity of electricity is due and that, for the present at least, managers must look to increase the residence load factor and income. Much of the domestic apparatus has been changed within recent months. Hermetically inclosed resistors are being adopted, the resistors being sealed within welded metal jackets, and the heaters can readily be removed for cleaning. Ranges are now made on which cooking can be done as quickly with electricity as with gas or coal, and the tendency is to pattern the devices after the gas range. Rates, however, are still the chief deterrent to the wide adoption of ranges, for in order to compete with artificial gas selling at $1 per 1000 cu. ft. electrical energy must be sold in the neighborhood of 3 cents per kw-hour. With such a rate it is possible to spot a town with electric ranges, and where lower rates prevail electric cooking has come into its own. With rates such as are offered in Ontario since the installation of the Hydroelectric Commission's service, electric heating and cooking should make rapid progress.

There are certain phases of the electric heating and cooking question, however, into which managers of central stations might delve deeply during the coming year with advantage if they have not already been brought face to face with the problems. Thus far the great majority of heating apparatus connected to central-station circuits have been of the small, portable variety which may be attached to existing lamp sockets. The use of such apparatus does not entail additional distribution expense to the central station and should be encouraged, since it not only increases the load factor of the system, but also brings in additional revenues and usually at the top rates. When the convenience of the apparatus is considered, expense, especially if it is not very great, is of minor importance. If it is desired to encourage the use of heating apparatus of this kind, and a schedule of rates similar to Hopkinson's is in force, the demand charge, or by whatever other name it may be called, can be abrogated, thus enabling all the energy consumed in a dwelling to be measured on a single meter and favoring the heating load by a minimum rate. Such systems are already in use in numerous localities. In the case of heavier cooking and heating apparatus, however, additional expense is involved both on the part of the central station and of the householder, who in addition seeks a reduced rate. Oftentimes the installation of a medium-size range does not call for heavier street circuits or larger transformers, although requiring heavier interior wiring. Where residential feeders have been installed, however, with an eye single to economizing on distribution and on load losses the installation of ranges will necessitate heavier copper and larger transformers.

Recently electric heaters have appeared on the market which, while consuming the same number of kw-hours, have the advantage of a greatly reduced maximum demand and an excellent load factor. In fact, by storing heat either in water or in an oven or cooker, it is proposed to give residence installations a load factor of 100 per cent with a consequent reduction in the price of energy—a consummation devoutly to be wished. Up to the present time the scheme has not progressed beyond the experimental stage, although it is fraught with great possibilities. The work has been confined to the storage of excess energy in water, rendering hot water available in the household at any time. When lamps or other devices are placed in circuit the water heater is switched out of circuit and vice versa. If this switching operation were performed automatically and without complication it would be quite an advance. Another form of heat storage is being tried, notably at Hartford, Conn., in connection with fireless cookers, and the progress made there is outlined elsewhere in this issue. Numerous other instances of heat storage in connection with fireless cookers and ovens may be cited, and work in this direction will doubtless be pursued energetically during the year.

In the industrial field electric heating continues to make haste slowly. Welders of all kinds which are automatic in their operation and do not require skilled labor offer advantages to manufacturers of great moment. For tempering high grades of steel the fuse-bath type of furnace deserves wider adoption than it has up to the present enjoyed. The printing, publishing and bookbinding trades continue to offer a wide field for the application of electrically heated apparatus; but in industrial work the general condition of the business of the country at large has a marked effect on the installation of new systems. The past year as a whole has not been an over-busy one in many industries, so that developments have been somewhat retarded, although many manufacturers have taken advantage of the lull and redesigned some of their apparatus.

Not all of the devices at present made meet the requirements of the user and a closer co-operation between maker and user is necessary before satisfactory devices are finally evolved. The same is true of some of the domestic cooking and heating apparatus offered for sale.

THE STORAGE BATTERY.

The past year has not been distinguished by any notable advances in storage batteries, if we except the notable progress made commercially by the Edison alkali cell. Recently the pasted plate has taken on new life, though it seemed at one time as if it was doomed to disappear as a commercial electrode, the Planté plate having been adopted coincidentally by several large American makers to the practical exclusion of the pasted plate. It appears, however, that the merits of pasted plates for "standby" batteries are meeting a deserved appreciation, and several large equipments have been lately installed in the lighting plants of the larger cities. For a reserve source of electrical supply in case of accident, such as lighting-station batteries on three-wire systems, and batteries across the exciter busbars of alternating-current plants, the pasted-plate battery is particularly suitable. It retains its charge well over a given period of time; it costs far less and occupies less space than the equivalent Planté plate battery, and is also cheaper to install by reason of its smaller weight and volume. Though not so durable as a Planté plate under continuous charge and discharge, the pasted plate may have even a longer life than the Planté where used only intermittently and occasionally.

An old friend, long lost sight of, has again come to the front—namely, storage-battery rail traction—and is receiving a cordial welcome. Several cross-town lines in New York City have operated several storage-battery cars for a considerable time and it is reported that the experience has been so satisfactory that all the horse cars in New York are to be displaced by cars of this type. They are very light, equipped with ball bearings, and chain drives are used between the motor and car axle. The schedule speed is low, about six and one-half miles per hour, including stops, but the cars give far better service than horse cars and they pay. There are many cases where battery-driven cars may be more suitable than trolley cars and better dividend earners, and a successful battery-driven car means that a new and considerable market is opened to the battery manufacturers.

After a long period of indifferent existence and critical trial the electric motor truck has proven to be a thoroughly commercial industrial vehicle and for most purposes far superior to the gasoline-engine truck. A considerable number of batteries have been used for these trucks during the past year and have helped to increase appreciably the volume of the battery business. The electric pleasure carriage has also grown in popularity and the number has increased greatly. The battery requirements for these vehicles have been the source of a large revenue for the battery manufacturers. The sparking-battery trade has remained practically stationary. This output is always a much larger proportion of the total battery production than is usually supposed, and a considerable variation in it has an important effect on the volume of yearly output. The widespread movement toward electric train lighting has greatly increased the demand for batteries for this purpose, and the trade in railroad-car batteries during the past year has been probably larger than ever before in the history of train lighting. These batteries are used both with axle-generator systems and for straight storage supply, in the latter case the battery being charged full at one terminal and discharging to the lamps throughout the run.

While the foregoing factors have contributed to increase the year's trade, the business in power-station and regulating batteries and auxiliaries has not been so active as in ordinary or normal periods. This is attributable to two main causes, namely, the financial situation and the increasing use of the steam turbine. During the past year electrical plants have had no money spent except for necessary repairs or equipment to handle load increases. The storage battery, being viewed by most operators as a refinement in power-plant design, is not contracted for except when good dividends and surpluses are the result of the year's operations, while its low cost makes the addition of a steam turbine in cases cheaper than an equivalent capacity in battery equipment, even based on very high discharge rates. Therefore, the steam turbine has recently been given preference in nearly every instance where increase in plant capacity has been necessary. Moreover, the flat consumption curve of the steam turbine, indicative of high economy on light and variable loads, and its almost instantaneous response to any change in load, have contributed to reduce the demand for regulating batteries. These considerations apply principally to the larger sizes of power plants where the capacity of the unit is 500 kw or over, as reciprocating engines are the prime movers commonly used in the smaller installations.

It has been freely predicted that the use of gas engines would greatly increase the demand for regulating batteries, as that prime mover has no overload capacity and works most economically at a certain fixed load. Up to the present time these predictions have not been justified—not because the regulating battery is unnecessary, but because the gas engine is not being adopted as a prime mover with the alacrity and unanimity that its advocates expected, nor will it be until the costs of gas-power plants are reduced. The total output of batteries, auxiliaries, plates and repair parts for 1910 is estimated to be in the neighborhood of $4,500,000.

THE ELECTRIC RAILWAY.

Steady progress along conservative lines, rather than startling innovations, has characterized the developments in the electric railway field during the past year. Of most interest, from the point of view of novelty as seen by the general public, was the introduction of the storage-battery car for service where the cost of change from horse traction to slot-conduit electric traction seemed not to be justified by the advantages to be gained by the change. Storage-battery cars, which one year ago were looked upon as being in merely the experimental stage of development, have proved admirably adapted for the service to which they have been put, and they bid fair

to drive the few remaining horse cars from the metropolitan traction field during the next few months. This result is attributable to developments in both the nickel-iron and the lead storage battery, the advent of the former in thoroughly serviceable type having hastened the improvements introduced in the latter. The past year has witnessed the terminal electrification of the Pennsylvania Railroad at New York City, the engineering features of which were along such well-established lines that little comment has been excited by the highly successful results obtained continuously from the beginning of service. However, the success has involved the proper operation of the locomotives, not all of the details of which have been of standard type. In certain of the mechanical features the locomotive represents a decided departure from electric railway practice in the direction toward steam railroad practice. Instead of abolishing the side-rod construction, which has at times been held to be a disadvantageous feature of the steam locomotive when compared with its electric rival, the designers have retained the side rods and adapted the electric motor to this type of construction. Experience with the new locomotives would seem to indicate that by mounting the driving motor in the cab well above the tracking mechanism, and providing constant torque throughout the revolution, the best features of both the steam and the electric locomotives have been retained, namely, smoothness of running and uniformity of tractive force in all positions.

Certain of the limitations encountered in direct-current motors built according to earlier standards have been removed by the application of commutating poles and redesigning the machines to take full advantage of the non-sparking conditions brought into existence thereby. During the past year complete lines of commutating-pole railway motors have been standardized. The need for the commutating pole is most urgent in motors built for high-voltage service, and the 1200-volt railway, which has proved well suited for interurban lines, owes its success to this auxiliary. However, the commutating pole is particularly adapted for use with motors subjected to highly fluctuating loads in which commutation rather than temperature rise is the feature which dictates the design limits. The frequent starting and stopping along city streets to which a railway motor is often subjected involve extremes of load fluctuations, and for this service the commutating-pole motor is quite as desirable as for high-voltage service. The 1200-volt, direct-current railway has proved thoroughly reliable, so that success can be predicted as the result of its selection with equally great assurance as is true with the 600-volt equipment. Almost all of the equipment now in 1200-volt, direct-current railway service is, in fact, neither more nor less than well-designed, doubly-insulated, 600-volt apparatus arranged for operation in series units of two at 1200 volts. The motors are designed for, and operate at, 600 volts, and they receive energy from 600-volt converters operated at normal e.m.f. The converters are connected in pairs joined in series to deliver 1200 volts, while the motors are not changed from the series to the parallel connection except in groups of two in series. However, each motor, as well as each converter, is insulated for the full line potential of 1200 volts. The flexibility of the arrangement has proved very advantageous for combined city and interurban service, since a trolley e.m.f. of 600 volts can be used whenever desired by placing the motors in the usual parallel position.

The outlook for the single-phase railway, in so far as any change has taken place during the present year, is brighter than it was one year ago. All of the compensated-series, single-phase equipments that have been installed have proved satisfactory, and in many instances substantial additions have been made to the equipments. The New York, New Haven & Hartford Railroad has greatly extended its single-phase service during the year, the new equipments including locomotives for both freight and passenger trains and multiple-unit cars for local passenger trains. The Rock Island & Southern Railway Company has installed single-phase equipments for both its freight and passenger service. In this connection it is worthy of note that items have appeared in these columns during the past year relating to recent single-phase railway installations in Sweden, Switzerland, Italy, Austria, England, France and Germany. A temporary setback to steam railroad electrification was caused by the decision not to equip the Chicago terminals for electrical operation. However, as time goes on the need for substituting electricity for steam will become more urgent, the cost involved in making the change will become less and the advantages to be gained thereby will increase, so that the change will be postponed for only a short time. In the meanwhile the continual discussion of the electrification problems will result finally in the substitution of electricity for steam in various neighborhoods. Pressure is already being brought to bear on the steam railroads in the Boston district. Philadelphia is beginning to look forward to electric traction service to New York, and the present decade will probably see the steam locomotive superseded by the electric locomotive in the Washington district, and possibly between Washington and Baltimore.

TELEPHONY.

In the evolution of every new industry or service there is always what may be termed a "formative" period, during which there is usually a struggle for capital, the determination of methods of production, development of processes, the construction and rapid improvement of plant and the establishment of prices and selling methods. These and other factors incident to the novelty of the business are so various and engrossing that little opportunity is given for a survey and consideration of the industry as a whole. That the telephone business has passed beyond the formative period could not be better indicated than by the analytical consideration of the activities of the past year or two, which have resulted in improved systems of accounting, analysis and studies of costs, consolidation of smaller companies into larger ones, mergers to eliminate wasteful competition, revised methods of administration, extensive advertising and the efforts to educate patrons to the use of the telephone service and deter them from its abuse. Of all these, the recent advertising and publicity campaigns have probably been most evident to the general public. The time was when almost every news item was viewed with suspicion by telephone managers. This policy of secrecy, of course, led to the invention of all sorts of fabulous.

yet undenied, theories concerning the telephone business. But now, following the trend of the times, there is apparent a counteracting influence, which is rendered evident in a broad, open policy of publicity and education. From the standpoint of the telephone employee, one of the most interesting developments is the so-called functional or three-line system of organization. The logic of this system is invulnerable. According to this plan, the business of the telephone company is considered to involve three main functions—namely, the provision and care of plant, commercial relations with the public, and the handling of the traffic. These three departments, the commercial, traffic and plant, work co-ordinately in their respective fields throughout the territory to be operated. Such an organization is conducive to a development of the best there is in a rightly placed employee, as his superior officers, however far up the line, are in a position to understand and appreciate the particular kind of work with which he is engaged.

The contest between the automatic, manual and semi-automatic systems has recently received much consideration, due to the considerable publicity given to a paper presented to the European Telephone Conference by Mr. J. J. Carty which touched on the subject. There is much in Mr. Carty's contention that all systems are really semi-automatic, the variations of different systems lying chiefly in the relative sequence of manual and automatic operations rather than in their proportion. Again there is a difference between the proportion of manual operations performed by the user and by the company. It is interesting to note that improvements in automatic systems lie almost entirely along the lines of safeguarding the manual operations against either careless or wilful error. On the other hand, improvements in manual switchboards have been in the direction of relieving the operator from manual operations and in additional automatic signals to attract her attention to necessary manual operations. A type of manual switchboard recently introduced in the Middle West is so arranged that the operator is relieved of the manipulation of all keys in the normal call. As soon as a cord is plugged to a call the operator is automatically put in talking connection with that cord. As the connection is completed to the desired line the listening connection is severed, and the intermittent ringing of the desired station is automatically initiated, stopping only upon the response of the called station or the abandonment of the connection by the calling station. Furthermore, the calling station is made cognizant of the actual ringing, as a small fraction of the ringing current is diverted back toward that station. There are now several such switchboards in operation which are giving good satisfaction to both the public and the telephone company. There is one feature of the automatic systems as thus developed which is not attained in the manual systems—namely, the instantaneous disconnection, which is a very valuable feature where a number of calls must be made in rapid succession. The advantage of this convenience is all the more accentuated by the fact that the slow disconnection or recall is probably the one feature of modern manual switchboards most unsatisfactory to the users.

This year has seen the extension of the long-distance range from the Atlantic to Denver, and conversations from ocean to ocean seem now within the probabilities of the reasonably near future. This probability rests upon the combination of the so-called phantom, the Pupin coil, and the telephone repeater, which together have extended not only the conversational range, but also the commercial range. For many years the system of Jacobs lay dormant, as the art of line building and apparatus building had not advanced to a point where the conditions could be controlled and made unvarying within the necessary limits. Then, suddenly, it was discovered that we were just upon the edge of the requirements, from which point it has been such an easy step that there are hundreds of so-called phantom circuits in use to-day. The name "phantom" is quite characteristic of telephone parlance, being founded upon the fact that two physical circuits, both tangible, combine to form a third independently usable circuit without additional wires. In the carrying out of the system the two limbs of each physical line are so associated through transformer or repeating coils that they may be used in multiple as one side of another line. The phantom line resulting from the association of two physical circuits is in effect a circuit of double cross-section and is made available by transposing the two associated circuits with respect to each other. The most important consideration is the fact that the superimposed circuit represents almost no investment. Heretofore it has not been possible to obtain the combined benefits of Pupin coils and of phantoms, but there has now been invented a combination coil which provides for the loading of both the physical and phantom circuits. Thus far there may be some doubt as to the availability of the repeater for use upon such a circuit However, now that this instrument is known to work satisfactorily within certain very special limits, experience under actual operation should guide inventors in the direction of wider application.

ELECTROCHEMISTRY IN 1910.

The past year's story of the now firmly established and, we might almost say, old electrochemical industries, of aluminum, carborundum, artificial graphite, calcium carbide, phosphorus, caustic soda and chlorine, is simple. No radically new development can be recorded, but rather a quiet, steady, effective commercial expansion into new fields of usefulness and along conservative lines. In the caustic and chlorine industry the case is somewhat different. The plant of the Hooker Electrochemical Company, using the well-known Townsend process, which was destroyed by fire in the summer, was rebuilt with remarkable speed, so that the works are again in full and successful operation. A new diaphragm cell of German origin was installed by the Niagara Alkali Company, which also took up the old Roberts process of making hydrochloric acid from cathodic hydrogen and anodic chlorine. The old tendency of New England paper and pulp mills to become independent of Niagara and make their own chlorine and caustic was further emphasized by the success of the Whiting cell at the works of the Oxford Paper Company at Rumford, Maine. This is a mercury-cathode cell, the chief feature which distinguishes it from the classical Castner-Kellner cell being a periodical removal of the sodium amalgam to the caustic compartment instead of the continuous movement in the latter cell. Liquid chlorine is now being made by several companies. The largest use is in the recovery of tin from scrap for the manufacture

of tin tetrachloride for use in the silk industry. This process is carried out on a large scale by the Goldschmidt Detinning Company at Chrome, N. J., and represents a new and complete departure from the old electrolytic detinning process.

In connection with the calcium carbide industry, the success of the calcium cyanamide works on the Canadian side of Niagara Falls deserves notice. In their process of fixation of atmospheric nitrogen, the nitrogen is first separated from the oxygen of the air by a comparatively simple chemical process, which represents a departure from the usual European method of liquefying the air and separating its constituents by fractional distillation. The nitrogen is then combined with calcium carbide at an elevated temperature, forming directly calcium cyanamide. This is sold as a fertilizer, either as produced or for mixture with other fertilizers, its fertilizing effect being due to the formation of urea from the cyanamide in the soil. This new fertilizer seems to have met with considerable favor. Perhaps of even greater interest is the projected 4000-hp plant to be erected by interests affiliated with the Southern Power Company in North Carolina for the production of nitrates by electric discharges through air. Both the Guye process and the Pauling process will be tried, the latter having been in commercial operation for several years in a plant at Innsbruck, Tyrole. This is the first undertaking of its kind in this country, since the much-discussed Bradley-Lovejoy plant at Niagara Falls stopped operation some years ago, before entering the commercial stage. The consideration which encouraged a trial was the availability of large amounts of power and the market for fertilizers in the South. While the manufacture of nitrates by arc discharges through air is also a case of fixation of atmospheric nitrogen, the process differs almost in every aspect from calcium cyanamide manufacture. In the manufacture of nitrates the raw material is simply air, and nothing is required but large amounts of electric power to combine a portion of the nitrogen and oxygen into nitrogen oxide; the resulting gas mixture is, however, so rich in air and so low in nitrogen oxide that a long and expensive process of concentrating the dilute gas mixture into a marketable product is required at the end of the process. On the other hand, in the manufacture of calcium cyanamide there is an initial expense, since the starting materials are calcium carbide and nitrogen (which must first be separated from the oxygen in the air). But in this case the electric furnace process yields in the form of cyanamide an almost directly marketable product.

In the applications of electrochemical methods to metallurgy, if we leave aside the distinctly electrochemical metals, aluminum, magnesium, etc., electrolytic copper refining remains of prime importance. In many years' working on the largest commercial scale the technics of electrolytic copper refining have been standardized in each of the large refineries to such an extent that radical changes can hardly be expected. Nothing new has been heard of the working of the Betts electrolytic lead refining process in the two American plants where it is in commercial operation. Quite a considerable activity is to be recorded in endeavors to improve the metallurgy of gold and zinc by electrochemical means, although definite results have not been reached in either case. In gold metallurgy a number of inventors and engineers are at work independently to devise an electro-amalgamation process, the idea being to improve the extraction efficiency of the amalgamating plate by making it a cathode. Considerable attention has recently been attracted to the Clancy modification of the cyanide process, which proposes the substitution of a cheap cyanamide solution, combined with electrolysis, for the more expensive cyanide solution as an effective solvent for precious metals.

In zinc metallurgy an improved dry chlorination process which has had several predecessors in this and other countries is to be tried in a new plant in Colorado, while quite a number of workers are actively engaged in developing electric-furnace methods for zinc smelting. The fundamental idea is, of course, the substitution of a large electric furnace unit for the small retort unit now in use. One electric zinc furnace, at least, has been in successful operation during the past year on a fairly large experimental scale in Upper Silesia, Germany, and it is interesting to note that this furnace was of American design. The largest new developments of electric furnaces are, however, to be expected in the metallurgy of iron and steel. The two 15-ton Héroult steel refining furnaces of the United States Steel Corporation, working in South Chicago in conjunction with the Bessemer converter and in Worcester in conjunction with the open-hearth have proven so successful that the Steel Corporation has secured complete control of the Héroult patents for steel melting and refining in this country. Very large installations are reported as under contemplation. The other problem of reducing pig iron from iron ore in the electric furnace is also approaching solution, the work being done independently, although along similar lines, in Shasta County, California, and in Sweden and Norway. The new Trollhattan electric pig-iron plant, which started operation on Nov. 15, is of special interest, as the work is being done under the auspices of the Jernkontoret, the official association of Swedish iron masters. The results obtained will, therefore, have an authoritative character. Nevertheless, in its newer applications to metallurgy, electrochemistry is still in its infancy; while there is concentrated activity on distinct promising problems, and gratifying evolution, almost everything in this branch is yet far from finality.

WIRELESS TELEGRAPHY AND TELEPHONY.

Progress in wireless signaling during the past year has been of an unusual nature, since it has consisted both of advances and setbacks. The federal government has shown unexpected activity in the prosecution of a number of firms which, the authorities allege, have been engaged in the development of wireless mainly as an auxiliary to their respective stock-selling agencies. Whether or not the government will be able to prove its cases is still an open matter; but if the charges which have been brought reflect the conditions which have existed it is high time that an art so necessary to the world's welfare should be relieved of connection with unsound financial methods. The unprogressive attitude which certain of the European governments have held with regard to wireless communication has greatly restrained its usefulness to the general public as a competitor of cable signaling. During the past year, however, there has been a change, and concessions have been granted for working over some important stretches of sea. South American

countries, however, are likely to benefit before we do, on account of the great difficulties which have been encountered in satisfactorily arranging for transatlantic wireless transmission. The wireless patent situation in the United States has steadily been growing more complicated. Legal activity is beginning, however, and it is greatly to be hoped that when decisions are handed down on the dozen or so wireless patents which are now in suit much of the confusion which has been due to the patent situation will be cleared away.

In spite of the handicaps which are preventing ether communication from reaching its full degree of utility, it has, in the past year, given a good indication of what this may be. Half a dozen vessels, on which were 300 or more people, have been rescued by the use of wireless from positions in which the fates of the crew and passengers were at least very uncertain. However, other recent examples, such as that of the S. S. *Cincinnati,* have shown how crudely the wireless is applied. The *Cincinnati* had a rough passage, and on both continents friends of the ninety-six cabin passengers were much worried, since no word could be had from the ship. On her arrival, two days overdue, it was explained that she "was too far away to send wireless message." This shows regrettable limitations in installing, since it is not difficult to obtain apparatus by the use of which a ship may keep in touch with land during an entire passage. One of the most significant accomplishments of the year was the long-distance test carried on by the navy in the early summer, namely, 3000 miles daylight signaling from a 600-ft. tower. When the requirements of this test were stated some time ago wireless engineers in general considered the feat too great to be thought of in the "present state of the art." Nevertheless, the test was made to indicate he feasibiliy of the proposition, and the result was so satisfactory that work on the high-power government station, to be located near Washington and to have a daylight range of 3000 miles, has been begun. The record figures for long-distance communication have been pushed upward. Under exceptional conditions (at night in the fall or winter) a distance of 6500 miles has been attained, and 3000 miles by daylight is scarcely more than normal working for well-equipped stations. Notwithstanding this, "records" of much shorter distances continue to be announced from time to time. The group frequency of 1000 per second which had been quite thoroughly tried out by the end of 1909, has had a year of fairly general use, and is showing up well. The prediction that the 1000-spark per second frequency would be much more easily followed by the ear through the irregular rumblings of "atmospheric" than are the lower rates of discharge has been well verified by experience. The navy is now installing some sixty outfits in which this higher spark frequency is used.

The methods of theoretical engineering necessary in the design of wireless instruments are daily reaching more firm foundations. In the study of the quantities involved in electromagnetic wave signaling it has been necessary to invent both methods of making measurements and apparatus for carrying them out. Conceptions of new physical entities and their relations with the ordinarily used quantities have had to be worked out, and the connection between standard alternating-current practice and high-frequency alternating-current practice has been established by necessity. Thus the tools for intelligent work in wireless are being rapidly developed, and the cut-and-try methods gradually done away with. The more progressive workers in the field have left the "accepted standards," and by evolving new methods and apparatus therefor have reached new degrees of usefulness. It is stated that by the utilization of several novel principles the harmful effects of even the worst "static" or atmospheric interference may be completely done away with; and those who have witnessed demonstrations of the late methods and who understand their technology are indorsing this statement without qualification. The application of the method to commercial practice is expected within the next few months.

Wireless telephony in America has suffered from over-exploitation and under-accomplishment. Promises ranging from opera music at 200 miles to telephony between New York and Paris have been very lacking in fulfilment. The majority of workers in this branch of wireless signaling have either feared or been unable to break away from the arc-and-microphone types of sender, and the general lack of progress is probably the result of this. Even the patents on space telephony have been exceedingly few, and the entire development of the science is quiet. Occasionally a wireless telegraph operator is startled by picking a "Hello! Hello!" from the ether about him, but practically no activities are announced. It may be that development is going on without the fireworks which usually accompany work in this line, and that announcement of unusual progress may be made most unexpectedly. If this is not the case, it is to be regretted that the work has been put aside, for wireless telephony should be able to offer the solution of transmission over distances which are impossible with wires or cables.

PROGRESS IN PHOTOMETRY.

During the past the development of photometry as recorded in the technical press has been transitional, but in the year just closed there have been exhibited marked indications of a new era in photometry. Just as in an investigation it is necessary first to design, set up and test the requisite apparatus, to develop methods and determine corrections, so it might be said that photometry has been in the formative period, and is now approaching a state of development where it can be used with some degree of confidence in the factory and test-room and applied with excellent results to the solution of important scientific problems. The simple laws which lie at the foundation of photometry are known, and their limitations are recognized. Satisfactory photometer bars and screens have been devised, and auxiliary apparatus, such as sectored disks, rotators and integrating spheres, have been developed and studied. Photometric methods have been standardized and satisfactory working standards have been provided. The ultimate primary standard has not yet been found, but the investigation of primary standards is still being pursued. Now is the proper time for such investigation, after the more immediate demands for suitable working standards have been satisfied. It is encouraging to believe that before long the Illuminating Engineering Society will have established a nomenclature which should reduce greatly the confusion due to the present lack of uniformity. A preliminary report was presented to the society

this year, but needed further consideration in certain respects before assuming its final form. It is to be hoped that its final form will be such as to make its recommendations acceptable abroad as well as at home, so that international as well as national agreement may be obtained.

One of the live questions in photometry at the present time, and one that must be settled before a wholly satisfactory status can be reached, is that of the comparison of light sources of different integral colors. This is not a new problem, but is one that has been elevated recently to a position of importance, partly, no doubt, because of the late developments in high-efficiency illuminants and partly because attention to this problem has only been possible after the more fundamental problems in homochromatic photometry have been solved. The flicker photometer, the commonest solution of the problem that has been offered, is quite old, but the careful, scientific investigation of the significance of its indications is just being undertaken. The more ardent supporters of the flicker photometer have made claims that are scarcely justified. Recent experiments have shown that at moderate intensities of illumination the results obtained by an observer with the flicker photometer are the same as those which would be obtained by the same observer by direct comparison in an ordinary photometer if the average of a large number of settings at different times is taken. With the flicker photometer, however, the error of a setting is very much less, probably because of the absence of the psychological element of an indeterminate criterion, which renders the direct comparison so difficult and uncertain. The flicker photometer, then, is no more or less than a quick means to a direct comparison, and hence would exhibit all the vagaries of the individual eye, so that the results of one observer might differ markedly from those of another with different color-sensibility. In the last analysis, however, this would appear to be the exact function which should be demanded of a photometer for the measurement of light-sources of different colors. If the instrument quickly and accurately gives the relative intensity of two light-sources, as an observer would obtain the relation by the more tedious and less exact method of direct comparison, it performs its legitimate function.

With the more exact knowledge regarding the flicker photometer that has been obtained during the past year we are in a better position to consider the question of the adoption of arbitrary standards for the comparison of differently colored light-sources. If each of the national laboratories should undertake to determine by the use of a standard flicker photometer, under standard conditions, the relative intensity of two such sources as the carbon and tungsten lamps, and should record the average of such determinations by a large number of persons with normal vision, in terms of the transmission coefficient of a suitable color screen such as would change the apparent color of the carbon lamp to that of the tungsten, then international agreement could be secured in heterochromatic photometry and the actual measurements in factories and testing laboratories would consist, through the employment of such calibrated color screens, in the actual comparison of light-sources of the same effective color. The promotion of this plan would come within the province of the research committee of the Illuminating Engineering Society, when that committee is appointed.

A résumé of the recent developments in photometry would be incomplete without brief mention of its application to the study of physical problems. Accurate photometry is a most valuable adjunct in the investigation of optical problems and has been used to that end with considerable success. With no other apparatus than an ordinary photometer and suitable electrical measuring instruments it has been possible to learn much about the radiating properties of metals. The influence of selectivity on the efficiency of metal-filament lamps has been shown in this way. The measurement of high temperatures in optical pyrometers is another illustration of the application of photometry in other physical measurements. The possibilities of its application are large and should be utilized now that the instruments and methods of photometry are well established.

ILLUMINATING ENGINEERING.

The most noteworthy event of the year in the illuminating engineering field was the giving of a course at Johns Hopkins University of thirty-six lectures by men best qualified to do so, the lecturers being selected by the Illuminating Engineering Society. This course marked the beginning of a new era in illuminating engineering and laid the foundation upon which the specifications for the profession will be based. Partly through the influence of the lectures and the annual convention held in Baltimore immediately preceding the lectures the activities of the Illuminating Engineering Society were greatly broadened during the year. Instead of dealing solely with lamps, and candle-power, and ft.-candles, the activities now embrace architecture, decoration, color effects, physiology, optics, commercial aspects of lighting, professional standing of the illuminating engineer, etc. The new year finds the society with a largely augmented membership and in a healthy condition, which promises growth in each of its many branches.

Among the numerous subjects to which attention has been directed during the past year perhaps none is of greater importance than the effect of quality and direction as well as the quantity of the light upon the eye. To an extent much greater than formerly the color of the light is being given consideration when deciding between rival illuminants. Attempts are being made to equal daylight in color quality by means of artificial light, and some go so far as to claim that the result has already been accomplished. While there can be no doubt as to the desirability of duplicating daylight for color-matching purposes, and a reliable reference standard for color work in photometry could well be one equaling daylight, yet opinions differ greatly concerning the most desirable color for general artificial illumination. Indeed, certain persons contend that the light from the tungsten lamp is too "white" and for many purposes the light from the carbon lamp is preferable. If one were permitted to judge intentions by the results considered satisfactory he would be justified in assuming that, previous to the last two years or so, the chief requirement in illuminating problems was the obtaining of a specific density of illumination upon the plane of reference quite independent of any other factor. At the present time it is appreciated that the prime requisite is to have the light source so hidden that the only light reaching the eye is that reflected from the object being viewed. The im-

portance of the above features has received greatly increased recognition during the year just passed.

Improvements during 1910 in the methods of manufacture of tungsten lamps have to a considerable extent overcome the fragility of the filament. The wire-type or "drawn-wire" filament tungsten lamp is so far superior to the earlier type of tungsten lamp that the accidental breakage, which was a determining element in the average life of the earlier lamps, has been practically eliminated, the fragility of the later lamps being no greater than that of carbon-filament lamps. In the flaming-arc lamps marked improvements have been made in the direction of increased life of electrodes with accompanying reduction in cost of maintenance. An electrode life of 100 hours is now being obtained in regular service, while a life of 140 hours is to be expected in lamps now being developed. So-called intensified-arc lamps are being employed to a rapidly increasing extent for the lighting of stores and similar interiors where color matching is of importance. The possibility of extended developments along an entirely new line was pointed out during the year in connection with the production by Dr. Peter Cooper Hewitt of a light-transforming reflector by the use of which the missing red rays can be supplied to supplement the light from the mercury-vapor lamp. As a result of this work it may be expected that the mercury-vapor lamp will find a greatly broadened field for application in locations where previously it was considered unsuited because of the lack of red rays in the light. The soft, well-diffused, penetrating light from the lamp renders it well suited for many purposes, but hitherto it has been barred from use where correct color representation was of importance. The field of the lamp has, therefore, been closely circumscribed, for color is of importance in the great majority of locations, and the lack of red is painfully noticeable even where one does not consciously attribute any value to correctness of color representation. When equipped with a reflector which acts as a secondary source of light of the proper color, the mercury-vapor lamp should prove a worthy competitor of the numerous high-efficiency, high-candle-power lamps now in use.

PRIME MOVERS.

The progress in prime-mover engineering during the past year has been along the same general paths which have guided the developments of the preceding few years. Coal and fuel oil continue as the sources of heat energy according to relative economy, availability and other special conditions. The chief outlying problems regarding coal relate to the utilization of low-grade forms, including lignite, slack, culm and other similar residue. To this end two ways are open—transformation into producer gas or combustion in the furnaces of steam boilers, either by special furnace arrangements or by combination and treatment in such manner as to produce some form of artificial fuel. All of these methods have received some attention during the year, but the urgency of the coal situation is not yet sufficiently keen to stimulate a general and serious study of these problems. The use of peat as an industrial fuel falls into the same class of problem, and certain interesting results have been developed during the year both in Canada and in the United States. The most hopeful indications seem to point to the utilization of peat through the gas producer and gas engine. The plants thus far experimented with have been of small size, and caution must be exercised in extending such results to larger units. It does not appear that the cost of heat energy from peat can, under present conditions, be made sufficiently low to compete seriously with coal except at considerable distance from the coal fields. The best grades of peat have shown from 7000 to 10,000-lb.-Fahrenheit units per pound of dried product, and in small units one hp-hour has been developed at the engine for about two lb. of such fuel at the producer, with correspondingly more in the case of a partially dried product. Regarding the status of oil fuel, an important series of estimates has been made during the past few years, partly by the U. S. Geological Survey and partly by private interests, the results of which have recently been partly made public. These estimates deal with the ultimate capacity of the crude petroleum oil fields in the United States, both those under present development and those in prospective or probable areas. Limitations of space do not permit a statement or discussion of actual figures, but the important fact is clearly brought out that, in all human probability, at any reasonable rate of increase in the rate of consumption, the production will meet the demand for a future period many times the normal life of all standard types of present power plant equipment. The conclusion is that in locations where oil is more economical than coal at the present time it should apparently continue to remain so for years to come; and, in any event, so far as supply is concerned, boilers, furnaces, stacks, etc., may all be designed with definite reference to the use of oil fuel rather than with any reference to the likelihood of a forced return to coal during the normal life of the plant.

Continued attention remains focused on the boiler room as the scene of large economies yet open to conquest. The CO_2 recorder in various forms, as well as simpler forms of apparatus for flue gas analysis, are all attracting increasing attention, and their records, when properly interpreted, are contributing to the closer regulation of air supply and to the more exact fulfilment of the conditions of combustion. It has been recently pointed out, however, that in many cases the use of such CO_2 recorders has been disappointing because it has been assumed that such indications by themselves furnish a direct and definite determination of economy. This is not the case, and it should be understood that the CO_2 percentage is only one of the factors of a complex result depending on many interacting conditions. In a given pound of fuel it is sought, of course, to liberate the entire amount of heat energy potential in the fuel, and to reduce to a minimum the heat rejected or lost by way of the chimney, radiation, etc. The principal item of this waste heat is, of course, that by way of the chimney, which depends on the total weight of gas, the temperature and mean specific heat; and the CO_2 percentage is only one of the factors serving to determine this combination result. Further experimental data are much needed showing the relation between CO_2 and boiler economy under varying condi-

tions of uptake temperature and other determining factors of the operative condition. More information is also needed regarding the economy of boilers under partial load and overload, and regarding the influence on economy of various departures in greater or less degree from the conditions for maximum economy. It has been demonstrated over and over again that under the best conditions boiler efficiencies of 80 per cent and better can be realized. With this fact in mind, every chief engineer should develop a most serious discontent regarding boilers which under approximately full load conditions fail to realize an efficiency of this order. Engineering progress in a broad sense calls not so much for the achievement of record results at isolated points and under specially favorable conditions, but rather for the raising of the general level of power-house boiler economy by from 5 to 10 per cent, a result which is demonstrably possible and which would realize a form of national conservation of the utmost importance, having in view the certain ultimate exhaustion of our present sources of heat energy.

The developments of the year in regard to prime movers fix the steam turbine still more definitely in its place as the typical form for electric generators, while for the direct mechanical drive of industrial works and for all types of direct drive where the speeds are relatively low the reciprocating engine still holds its place. All this is in exact accordance with what has been often repeated in these columns—that the choice between the highest types of steam turbine and of reciprocating engine is to be based on considerations of adaptation to the service required rather than on arguments of thermal economy under test conditions. Both types show economy in the same class, but the peculiar characteristics of the turbine have shown such definite adaptation to the demands of electric service that few engineers would to-day give serious consideration to reciprocating engines as the sole prime mover for large central station equipment. Attention still remains focused, however, on combinations of the two types—reciprocating engines for the high-pressure end of the steam cycle and turbines for the low-pressure end. This may be of peculiar value in connection with the extension of present existing stations, where, by the addition of low-pressure turbines, the output may be greatly augmented, while in certain cases the system may be properly considered for new installation. These combinations have given rise to special problems in connection with the design of mixed pressure turbines in order that either high or low-pressure steam may be used in such turbines to the best advantage. Recent tests have indicated that the economy of such combinations may be made superior to that of either type singly, operating under the same general conditions, and with an economy curve remarkably flat over a very wide range. One of the most notable of such installations is that in the Interborough station in New York City. The combination doubles the economic output of the original engine units and gives an extraordinary flat economy curve of value, rivalling or exceeding the best of results from turbines alone and showing a heat consumption about 77 per cent that for the engines alone and as originally installed.

A striking increase in the economy of small units has been realized in Germany, where compound engines of the so-called "semi-portable" type of 50 hp and upward are reported as developing energy at the rate of 1 to 1½ lb. of coal per 1 hp-hour and with an engine efficiency of 19 to 20 per cent. As described during the year in these columns, the cylinders are located in the steam dome and form one casting with it. The steam is superheated to a temperature of about 650 F. before entering the high-pressure cylinder of the engine and again reheated between the high and low-pressure cylinders. This superheating and reheating is effected by the waste gases from the boiler. The detailed arrangements of the combination may well be studied by American engineers as an interesting example of methods of reducing heat wastes and of raising the over-all plant economy of small installations. A similar simple non-condensing type is also reported as showing a corresponding improvement over the usual economy of its class. In the field of internal combustion prime movers but little definite progress has been made during the year looking toward the extended use of such types in large sizes for central station service. The unit of small or moderate size, on the other hand, is advancing steadily in general favor and seems destined rapidly to absorb a very considerable share of the field now occupied by the reciprocating steam engine and boiler. Such units may operate on liquid and gaseous fuels of various grades, and particularly on producer gas made from coal of all grades down to and including lignite and other fuel useless under present conditions for steam generation. Hopeful results have also been reached in California with producers using oil fuel, and a considerable number of such plants are likely to come into service during the next few years. The Diesel engine seems also to be gaining in favor for units of moderate size, and excellent results have been reported from this type, in one case covering a period of three years' service. For large central-station service, however, the internal combustion engine has still to demonstrate more clearly its superiority to the steam boiler-turbine combination, which is typical of this field of service. In the Gary plant, however, which contains thirty-three 3000-hp units, a large number of which are used for electric generator drive, excellent results have been realized, and the most encouraging reports have been made as to the general success of the engine as a prime-mover for such service. While the regulation for operation in parallel is naturally inferior to that with turbine drive, it is stated that in this respect the gas engines are in the same class with steam engines, and that no trouble from cross currents between generators has developed.

In the field of auxiliary equipment passing mention should at least be made of the centrifugal pump for boiler feed, of the rotary type of air pump and of the steam regenerator for reducing heat wastes due to irregular demands of the loads, all of which are attracting increasing attention and seem destined to take their place by right among the typical features of power-house equipment. The past year has witnessed the construction or installation of several items of power-house equipment, making notable advances in the output rating of such units. Mention may be made of the following: Steam boilers of 7000 kw operating rating each, and allowing at full load only 2.48 sq. ft. heating surface per kw-hour generated. The high rate of evaporation per square foot of heating surface in these boilers will be noted. An independent superheater of 8000-hp rating to use waste heat from billet

furnaces. A 25,000-hp exhaust steam feed-water heater and purifier. A surface condenser of 25,000 sq. ft. cooling surface. A two-stage centrifugal pump for boiler feed of normal rating of 25,000 boiler horse-power, or 1600 gal. per minute, guaranteed to deliver against a total resistance of 300 lb per square inch. Such items, together with turbine units of 14,000 hp and over, indicate impressively the rapid advances in size which have marked the recent progress in power-plant engineering.

RURAL ELECTRICAL DISTRIBUTION.

Surveying the progress made in introducing and extending the use of electricity on farms in the United States during the year just closed, the observer may report some progress. This is especially true in the case of the isolated electric farm plants, which are now far less rare than in the past. Manufacturers of agricultural machinery, gas engines, gas producers, storage batteries, small dynamos and motors, and low-voltage lighting equipment are keenly interested in this development and are fostering it with zeal and intelligence. The subject is discussed in the agricultural journals and at meetings of agricultural societies and gas-engine builders. It is evident that for some years to come a large proportion of the electricity used on farms will come from private generating plants on the farmer's premises, since few farms can now obtain service from central stations or transmission lines. Several companies make 24-volt to 48-volt outfits, more or less complete, consisting of gasoline engine, dynamo, storage battery, switchboard, tungsten lamps, wiring and fixtures, and perhaps two or three small motors. A large number of these low-voltage sets have been sold during the year. More elaborate equipments include gas producers or are driven by steam engines or water-wheels, in the latter case the plant being frequently almost entirely automatic in operation. It is fair to assume that some of the private-plant owners, as the years go by, will be fair "prospects" for central-station service if the latter is available at a fair price. The use of electricity on farms is sure to be greatly increased with the progress of intensive cultivation, which is becoming an acute national need; and in the country, as in the city, the question of central-station service versus isolated plant must be fought out on its merits in each individual case. At present, in many cases, it is simply the private plant or nothing, and the makers of the apparatus used in these small installations are entitled to credit for the ingenuity and enterprise they exhibit in enabling the farmer to have the benefits of electricity at a moderate cost.

But while the private-plant men have been especially active, the central-station interests have been by no means idle. It is recognized that the subject of rural electrical distribution is really of great importance for the immediate future. One does not need to go so far as the enthusiast who figured that if each of the 5,737,372 farms in the country in 1900 had 50 hp in electric motors installed the manufacturers would be called upon to furnish 286,868,600 hp in motors, with generators of a corresponding rating, while the central stations would be required to furnish energy in amount far beyond anything imagined by the "popular-science" man who writes for the Sunday newspapers. Central-station companies in certain parts of the country are, however, beginning to give serious attention to the problem, and the number of farm customers is now considerable in some sections. There was a paper on "Electricity on the Farm and the Influence of Irrigation" at the St. Louis convention of the National Electric Light Association last May and another on "The Promise of Electrified Agriculture" at the Frontenac convention of the Edison Companies last September. Quite recently the new Commercial Section of the N. E. L. A. has appointed a committee of nine members to examine and report at the next convention on "Electricity in the Rural Districts," with a chairman who is general contract agent of one of the large suburban central-station companies of the Middle West, and during the present year this journal will present information on the subject gathered by its field editors.

But how is the distant central station to supply the electricity needed for operating farm machinery and lighting houses, farms and outbuildings at a profit to itself and at a rate satisfactory to the consumer? Evidently the question is one of high-tension distribution with the use of small transformers on customers' premises. Expressions of opinion were asked as to operating experiences under these conditions in a recent "Question Box" discussion of the N. E. L. A. Answers were received from managers in California, Washington, Indiana, Virginia, New York and Colorado. The consensus of opinion seemed to be that from 6600-volt to 10,000-volt primary service is entirely practicable. But it was pointed out that the average farmer is a small consumer and that the cost of the transformer and the transformer losses must be considered in taking on the business. A central-station man who has given considerable study to the subject offers this suggestion: Where the central station is distributing 2300/4000-volt service along country highways, require the customer to purchase the transformer and pay for all secondary distributing lines on his farms; the energy to be measured on the primary side of the transformer, the company furnishing the meter, which, like the transformer, is to be installed on the highway, and the customer to pay for his lamp renewals. No maximum is to be demanded and a reasonable rate is to be made for energy furnished. Naturally, the farmer's motor business is off-peak load and his lighting requirements are small, because he and his household go to bed early. Consequently, the farmer's business is desirable because it does not add appreciably to the peak load.

Interurban railway companies have done considerable business in selling electricity to farmers, not so much for the income, which is usually small, as to accommodate men whose property is crossed by the railway. Usually the farmer furnishes his own line from the railway to his house and barns, using 550-volt direct current from the grounded railway circuit and burning his lamps in series-multiple. The railway company supervises the installation and advises the farmer to have the work inspected by his insurance company before service is given. At the present time there are about fifty farmers and dairymen within a few miles of Elgin, Ill., who are using electricity in this manner. One development of the year to which reference must be made is the attention paid by central-station men to electric pumping for irrigation in humid regions. There has been a great deal of irrigation and incidental farm load

developed by electric service companies in semi-arid regions in California, Washington, Oregon and Colorado, but only recently, apparently, has it occurred to Eastern electrical men to promote similar business in the East during the periods of drought which are experienced every summer in the Eastern and Central States. The Rochester (N. Y.) Railway & Light Company has installed electric pumping plants in fruit farms and market gardens near that city with most encouraging results, as mentioned in the N. E. L. A. paper to which reference has been made. Some work of a like character has been done on the outskirts of Chicago also. An enterprising market gardener living within four miles of the city boundary buys central-station energy not only to light his house and farm buildings, but also to operate a 5-hp centrifugal pump by which he lifts water from a river to irrigate his growing crops during prolonged dry periods, thereby getting ahead of his competitors in forcing his produce for the early home-grown market. He paid for the pumping installation and a portion of the cost of the line serving it. On the southern border of Chicago, where the land is low, there is a 600-acre farm where electricity from a central station operates a 15-hp, single-phase motor which drives a 12-in. vertical centrifugal pump used to draw the water off the land and discharge it into Calumet Lake. By the use of this electrical energy two crops of hay are grown yearly, making valuable land of what would otherwise be a useless marsh. These modern instances show the benefits of electric irrigation and drainage in localities where the possibilities of such development have been unsuspected hitherto. They are but glimpses of that expansion of the use of electricity on the farm which the future will surely show, particularly when the era of intensive farming arrives, as it surely will arrive from the pressure of economic forces that cannot much longer be resisted.

THE WATER-POWER SITUATION.

The policy of the government toward conservation generally, and particularly toward the treatment of water-powers on lands under government control, remains still undetermined and the subject of much discussion. We have several times considered this matter in its various aspects and pointed out both the dangers of no control at all on the part of the government and the risks of inefficiency in development that will be run by the promiscuous development of water privileges without a coherent plan of coöperation. As to the existence of a water-power trust, which is endeavoring to grasp all the hydraulic resources of the country, we have oftentimes expressed skepticism and see no reason to change that attitude. On the other hand, it must be admitted that there is a keen realization on all sides of the value of the power privileges of the country at large, and that there is danger that they may be pre-empted for speculative purposes in such wise as seriously to interfere with their development to the best public use. This is, in our opinion, however, not the result of the machinations of a water-power trust, either fully or partially organized, but of a general recognition of values and a general tendency, which is here, as everywhere, dangerous, toward a policy of obstruction aimed by many large financial groups at the independent development of anything.

It must be frankly admitted that it is an extremely difficult matter at the present time for persons unconnected with one of half a dozen financial groups to carry out any considerable enterprise in any field of activity. So complete has been the tacit alliance of various interests within the last ten years that in any operation requiring one or several million dollars capital it is almost impossible to secure the funds without dependence on one or another affiliated junta of capitalists. It is a perfectly general tendency which displays itself unquestionably in water-power development, but no more so than it would in the case of building a railway, or establishing a new packing-house, or starting a steamship line, or opening a big shoe factory. Whether this situation is one that demands immediate and drastic remedies or not we leave to the exponents of the "dismal science" to decide.

As regards water-powers, it is important that they should be developed according to a definite plan, wherever the capital is obtained. It is equally important, in our opinion, that so far as possible they should be developed under pretty close public control on account of the quasi-public nature of the business. It makes little difference from whose strong-box the money for the work is obtained. It makes a great deal of difference whether there is governmental control sufficient to insure that the development shall not be grossly over-capitalized, shall be administered according to a systematic plan and shall furnish energy at equitable prices to all comers.

At present anything like effective conservation of the water-powers of the country and regulation of their development is impossible on account of an open quarrel between the general government and the States as to their respective rights in the matter. We had occasion not long ago to point out the need of action by the general government in the case of powers involving interstate rights. As in many other matters, such action is becoming of far-reaching importance, and it remains to be seen what Congress and the Supreme Court will do with the somewhat loose constitutional provisions under which action could be taken. In theory, State regulation of all matters regarding conservation ought to be more efficient than regulation by a central government which is supposedly not in close touch with local necessities. In practice, it has been over and over again demonstrated that local authorities are too easily reached by large financial interests with axes to grind, so that the guidance of such affairs by powers that care comparatively little for the feelings of local magnates is sometimes much to be desired. A few interested cattle men or lumber men may stave off policies of conservation until there is nothing left to conserve, if they can work directly upon State politics. It is the old question of good theory versus bad practice. Just at present it appears that the advocates of local authority and those of general authority are at a deadlock, which, in the interest of the people at large, should be broken as soon as possible in order that either one party or the other to the dispute may have opportunity to make good its protestations of belief in conservation. The water-powers of the country are too valuable to be thrown into the hands of promoters or pushed into hasty or improper development. It would do no harm for both the State governments and the general government to sit tight for a while and think the problem over.

PUBLIC-SERVICE REGULATION.

The attitude of the States toward public-utility corporations in 1910, as indicated in commission regulation, appears to have been modified. It is not exactly, as some would have us believe, a tempering of the wind to the shorn lamb. The subject of active public regulation of electric lighting corporations is generally associated in the public mind with the control of other classes of public-utility companies, and in most sections of the country the aspect of this subject that has ranked foremost in importance during the year is the steam-railroad rate situation. The overshadowing influence of this situation and the effect of its settlement upon the railways and the industries which are wholly or largely dependent for activity and prosperity upon railway purchases have helped to divert the public mind from serious attention to occurrences of a more purely local nature. In the meanwhile other influences have been at work. As corporate abuse was responsible in part for the public dissatisfaction which underlay the law enacted in New York State and encouraged similar threatened legislation in other States, so a reformative attitude on the part of the corporations has led to a more willing acceptance of the conditions desired by the companies. In an editorial in these columns in the first issue of January, 1909, the opinion was expressed that the movement for regulation probably never would have reached the full extreme to which it went in New York State if officials of companies not directly under attack had tried to meet the agitation half way and striven to secure legislation that would be reasonable. Since that time the intensity of the movement has receded and the corporations have progressed toward a common ground on which the issues between producer and consumer, that is to say, the bargain between seller and buyer, ought to be settled with fairness to all. The danger in reaction is that any regulative policies which States adopt will be rendered so weak that they will be of no real protection either to the public or to corporations. If that danger is recognized as one that should not be ignored in a thoughtful consideration of what the future may bring forth it must be realized that too weak a policy may leave an opening for abuse in management of which some may take advantage, and also for an intolerant attitude toward the public into which various corporations, forgetting the lessons of the last few years, may fall again. Where regulative commissions are to exist at all it will be to the ultimate interest of the companies to have their powers reasonable and fair to both the corporations and the public and to have the membership of such bodies made up of men who will administer their powers in this just spirit.

New commissions were created during 1910 in the States of New Jersey, Maryland and South Carolina. The Corporation Commission of Oklahoma has assumed, under authority of the general act under which the commission was created, jurisdiction over electrical corporations. The Maryland law follows closely the text of the original New York public-service commissions law, but it includes a specific provision for a court review, which was purposely omitted in the New York law. Although the New Jersey and South Carolina laws are not comparable, in the authority which they permit, with the earlier laws of Massachusetts, New York and Wisconsin, they are still steps in the irresistible movement for regulation which is passing through the country. The laws now in existence present wide extremes of the regulative policy of States; likewise the commissions which enforce these laws present in their membership extremes of character and ability. A strong commission can make a weak law an effective instrument, while a weak commission can make a strong law ineffective. More than one commissioner has assumed office with the notion that his duty would be to protect the public against the corporations, but experience has taught him, not only that it was his equal duty to protect the corporations against the public, but that no other policy would serve the public interest in certain cases. A rigid policy of protection of one interest without fair protection of the rights of the other interest will bring punishment upon itself through a later reactionary sentiment and legislation. With some States it will be a question of whether regulation is desired or the investment of outside capital is desired. Certainly there will be no substantial development in some localities unless, either by precise statute or the absence of statutory prohibition, or by commission or absence of commission, openings are allowed for profits in the promotion of new enterprises. Even under some of the most rigid of the commission laws avenues are left open for that profit without which substantially no speculative funds would be available for the promotion of new undertakings. In New York State the services of promoters have been recognized as valuable services for which securities might properly be issued. In the State of Wisconsin the law distinctly provides that discount on bonds shall be charged to capital account. This is done on the ground that such discount is part of the cost at which the capital is secured.

Another element in the situation the influence of which is sure to be felt during the coming year is the recent party change in political ascendency. Regulation has been a policy of the Republican party in the past, but its extension, so far as the national supervision of railways is concerned, will follow lines that can be seen less certainly now than before the upheaval which occurred in November. Long before the complexion of the House of Representatives will become Democratic, the State of New York has seen the accession to power of a new administration. As a result of the changes in Governor and Legislature in New York rumor has played havoc with the public-service commissions law of 1907 and with the retention in office of various members of the commissions by whom it is enforced. Where the rumors are so thick and arise with such apparent show of authority it seems certain that some changes will be attempted, although with what final result only the future can tell. By reason of its administration of the law and its unusual appreciation of the problems of small companies the New York Public Service Commission of the Second District has taken rank with the ablest and fairest commissions of the country. While the New York situation may change and no doubt an attempt will be made to introduce greater economy of methods we should regret to see a backward step taken. Regulation, if both wise and reasonable, is in the permanent best interest of the corporations. In New York, as well as in other States, a regulative policy will afford an outlet for radicalism and an argument against the far more dangerous, but often threatened, spread of municipal ownership.

New Jersey Public Service Corporation Pension and Benefit System for Employees.

A pension system, together with life insurance and sick or disability benefits, was put into effect by the Public Service Corporation of New Jersey and allied companies Jan. 1. The benefits will affect all the permanent employees of the street railway, gas and electric companies, including those acquired by the corporation during the last year. In no case will the men be asked to contribute any portion of their wages, as the expenses are to be borne wholly by the employing companies.

About 10,000 men will be affected by the company's action and the cost of the general scheme will, for the first few years, be at least $50,000 a year. Later it will be more. Provisions are made for pensions based on percentages of wages or salary, with the minimum fixed at $240 a year. As sick or accident benefits one dollar a day will be paid during disability, not exceeding ninety days in any one year, and the insurance money payable on the death of an employee will be $300.

Voluntary retirement at sixty-five years of age and after twenty-five years of continuous service and compulsory retirement at seventy after twenty years' service are provided for. The pension will amount to 1 per cent of the average annual salary paid the person retired for ten years previous to retirement, multiplied by the number of years of service. Thus a man who had received $1,200 a year and had worked thirty years would get 1 per cent of $1,200 multiplied by thirty, or $360 a year. All present employees will receive the insurance if they continue in the company's employ until death, but new employees will have to serve one year before they acquire insurance rights, and then such rights will be dependent upon continuous service thereafter. Pensioners will not be paid sick benefits, but retirement on pension will not deprive an employee of the insurance benefits.

The Public Service Corporation is believed to be the first utility company in the country to put into effect a complete pension, death and sick benefit scheme for its men without expense to the employees. The pension and benefit funds will be administered by a welfare committee, of which the second vice-president of the corporation will be the chairman. The other members of the committee will be the president, treasurer and general claim agent of the company.

Telephone-Rate Investigation in Chicago.

While admitting that the existing schedule of rates of the Chicago Telephone Company may be inequitable between the different classes of subscribers, the telephone sub-committee of the committee on gas, oil and electric light of the Chicago City Council in its report following a study of the company's business, dated Dec. 28, 1910, finds that the present rates yield sufficient revenue to pay all the operating expenses, taxes and depreciation, together with a return of 10 per cent on the present value of the plant, which is placed at $19,053,169. The investigation was in charge of Mr. William J. Hagenah, formerly expert for the Wisconsin commission, and was made under the direction of Aldermen W. J. Pringle, chairman; C. E. Merriam and T. K. Long, of the City Council.

The present investigation was ordered with a view to checking the results and conclusions obtained in a report on Chicago telephone rates, submitted in May, 1910, by D. C. & W. B. Jackson, engineers, and Arthur Young & Company, accountants. The earlier report dealt with the cost of maintaining each class of service and the revenue therefrom and found a net deficit of $908,533. Certain services cost more than the revenue derived from them, while others paid in excess of their pro rata share of operating expense. As the result of this investigation, the telephone company asked permission to increase certain of its charges so as to net about $1,200,000 additional income.

The later report, prepared by Mr. Hagenah, assumes a book value of the property of $23,406,126, from which is adduced its present value of $19,053,169, considering depreciation of plant equipment and appreciation of real estate. The replacement value of the property is placed at $22,115,764, of which $20,448,304 is subject to depreciation. Taking a condition factor of 77.5 per cent, the present value of this depreciable plant is given as $15,847,456. No consideration is apparently made of the going or organization value of the company in arriving at its present value of $19,053,169.

The total Chicago revenue is found to be $8,321,609.69, divided as follows:

Exchange earnings	$7,608,817.88
Toll earnings	588,827.50
Private-line earnings	12,447.62
Real estate revenue	30,730.99
Dividends and interest	49,188.84
Miscellaneous revenues	31,596.84
Total	$8,321,609.69

The operating expenses of the Chicago exchange were analyzed as follows:

General	$420,063.86
Rentals	357,413.49
Operating	2,444,200.74
Maintenance	1,492,756.17
Reconstruction	812,227.45
Miscellaneous	569,103.20
Total	$6,095,764.91

Besides finding that the gross corporate income is equal to 10 per cent of the present value of $19,053,169, or 8 per cent on the book value of $23,406,126, sufficient to pay the present 8 per cent rate of dividends, the investigators commented adversely on the instrument rental charges of $355,711 paid to the Bell interests, which they believed would be adequately represented by $135,000 at present market rates. The service charge of 2.87 per cent paid to the Western Electric Company on purchases for warehouse service was deemed to be an advantageous arrangement for the telephone company, saving it heavy warehouse costs. Mr. Hagenah gave it as his opinion, in the conclusion of the report, that any increase in rates is unwarranted at this time.

Good Year for Brooklyn Edison.

The year 1910 has been the most prosperous in the history of the Kings County Electric & Power Company and the Edison Electric Illuminating Company of Brooklyn. The former is the owning and financing company in control of the entire lighting industry of the Borough of Brooklyn, and the Edison company is the operating organization, which deals with the consumers. The broad-gage policies of the company in its dealings with the public, the efficiency of internal operation, and the alert and progressive methods used in securing and retaining business have produced a development within the year just past which exceeds all previous records. The increase in gross earnings during 1910 amounts to approximately $600,000.

The ratio of expenses to earnings has been improved and the net result correspondingly increased. After charging more than $525,000 to depreciation, the net divisible surplus for the year will be at least 9¾ per cent and possibly 10 per cent on the total capital stock of $10,000,000. During the year the Kings County company issued $2,500,000 of 6 per cent debenture bonds, the full interest of which has been included in the year's expenses. Expenditures for capital purposes are increasing in amount year by year, keeping pace with the growth of the borough and aiding particularly in the development of the outlying sections. Dividends have been continued on the Kings County stock at the rate of 8 per cent per annum. This rate has been paid continuously since its adoption, the disbursement of Dec. 1 last being the forty-third consecutive dividend.

Possibly the most noted development during the year was the institution of the profit-sharing and pension plan, which was

announced in these columns last month. In this feature of welfare work the Brooklyn Edison company has taken the lead. It is the first of the large corporations in Brooklyn to establish such co-operative measures as between stockholder and employee. The directors of the company decided to share the prosperity of the company in a substantial manner with the employees, and on the first of the year each employee who has been with the company five full years was credited with a sum out of the divisible surplus of the company's operations for the year equal to 8 per cent upon his salary, or the same amount of dividend as the stockholders receive on their holdings. The employees who have been in the service of the company four years receive 6 per cent; three years, 4 per cent, and two years, 2 per cent of their year's salary. These dividends to employees are credited in their names in the Brooklyn Edison Investment Fund, an organization established during the year, in which the employees of the company invest their savings or a portion thereof in the securities of the company. There is now invested in this fund over $70,000, the property of about 750 of the company's employees. After three years the employee's profit-sharing investment becomes available for withdrawal in stock if he so desires. Before the expiration of the three-year limit, however, such profits as are credited to an employee may be withdrawn to make payments upon the purchase of a home, or in case of the death of the employee, or because of unusual necessity in the opinion of the committee having jurisdiction.

A system of pensions for aged and incapacitated employees who have been with the company ten years or longer has also been established. This is more liberal in its provisions than similar systems in effect in the large corporations in this country.

The lighting and industrial load connected to the company's mains, which is computed in "50-watt equivalents," during 1910 reached a total in excess of 2,000,000. It took from 1889, when the company began business, to 1907 to amass a business which amounted to the equivalent of 1,000,000 units. The connected load added in the past three years is, therefore, equal to that connected during the previous eighteen years. The additional connections during 1910 amount to the equivalent of about 300,000 lamps. The amount of electrical energy generated and consumed was greatly in excess of that for any previous year, and the amount of energy sold during the month of December just closed exceeds that for any previous month in the history of the company.

One of the factors in this very large increase in new business that has especial significance as bearing on the industrial growth of Brooklyn is the rate offered by the company for energy used by motors. It has not only caused many Brooklyn plants to change over from gas or steam equipment to electricity supplied by the Edison company, but has also aided in inducing a number of large enterprises to locate in Brooklyn.

The Brooklyn Edison company, in connection with the city authorities, has accomplished much during the year calculated to aid in the growth and development of Brooklyn, and this particularly with respect to a notable increase in city lighting. An adequate system of street lighting is not only a vital necessity as far as convenience of citizens and the prevention of crime are concerned, but it is an excellent advertisement for a community. The number of city arcs has been increased in Brooklyn during the year to over 5000. The Manhattan Bridge has been illuminated. Fort Greene Park and Prospect Park have both been equipped for the first time with an adequate system of electric lighting. The posts used are artistic and were designed by the Municipal Art Commission. In Prospect Park 450 of these posts have already been installed and 300 more will follow, this equipment replacing 150 gasoline lamps. Each of the new posts carries an 85-watt tungsten lamp. The posts are placed on all drives and walks 100 ft. apart. This gives Prospect Park a modern illumination and places it on a par in this respect with Central Park in Manhattan and other first-class parks throughout the country. The city has also contracted with the Edison company for 400 hp to operate the flushing pumps for cleaning Gowanus Canal. This system will be placed in operation early this year.

An interesting development that has taken place during the year is the inauguration in Brooklyn of merchants' decorative street lighting. The first installation of this kind has taken place within the last two months on Bedford Avenue, as noted in these columns at the time. The equipment consists of a number of artistic posts, each holding five 100-watt tungsten lamps surrounded by opal globes. The local merchants themselves contract and pay for this street illumination with the idea of increasing the attractiveness of their respective localities. The company has a number of contracts already under way for this type of lighting in different parts of the borough, and the indications are that it will spread during the coming year.

Among the customers who have discontinued the use of their private plants for Edison service may be mentioned: Steeplechase Park, Coney Island, 1200 hp; the New York Dock Company, 1200 hp; Gretsch Corporation, 440 hp; Shultz Bread Company, 250 hp; Clarendon Hotel, 1000 lamps and 100 hp; also about 125 other plants ranging in capacity from 5 hp to 200 hp. Renewal contracts have also been signed for the supply of all lamps and motors to Luna Park, Dreamland, Brighton Beach and the Manhattan Beach Estates, Coney Island.

Dry dock No. 4 at the Brooklyn Navy Yard has been built entirely with energy supplied by the Brooklyn Edison company. This required a maximum of about 1000 hp. All the contractors for the Fourth Avenue subway have signed agreements with the Edison company for the supply of electricity and are using the energy in the construction of this great public improvement, for which the city has already appropriated $15,800,000.

A comprehensive plan to secure the electric equipment of unwired Brooklyn residences has also been inaugurated during the year and is meeting with gratifying results. This plan, widely advertised by the company, consists of an offer to install electric equipment for any house owner in the Borough of Brooklyn, payment for which may be made in instalments with the lighting bills as they become due.

Two other notable features contributing to the total of 1910 achievements are the largely augmented sale and use of household cooking and heating appliances and the increasing popularity of the electric vehicle, some of the largest concerns in the borough, including the department stores and express companies, having adopted or extended the use of these vehicles during the year. Mr. W. W. Freeman is vice-president and general manager of the company, Mr. W. F. Wells the general superintendent, and Mr. T. I. Jones the general sales agent.

Central-Station Insurance.

At the St. Louis meeting of the National Electric Light Association statistics were presented by Mr. W. H. Blood, Jr., insurance expert of the association, tending to show that fire insurance premiums paid by the electric lighting companies of the country are fully twice as high as the low ratio of loss would warrant. Resolutions were adopted by the association asking for an investigation of the subject by the fire insurance companies and directing that copies of the resolution be furnished to member operating companies so that they might take up the matter with their brokers. A thorough campaign along these lines has recently been organized as fitting at this season of the year, and large numbers of copies of the resolution have been placed in the hands of the operating companies requesting them to bring the matter to the attention of their insurance brokers. Letters have also been written from association headquarters to some 250 insurance companies calling their attention to the matter and inviting them to investigate the subject with a view to a reduction in rates commensurate with the premiums received and the risks involved. An extremely interesting report and analysis of the subject generally was presented at St. Louis by Mr. Blood and has been reprinted in the annual proceedings of the association.

Meeting of Boston A. I. E. E. Section.

At the regular monthly meeting of the Boston branch of the American Institute of Electrical Engineers, held on Dec. 21, Chairman J. F. Vaughan presiding, an illustrated talk on the Panama Canal was given by Mr. D. B. Rushmore, of the Power & Mining Department, General Electric Company. Mr. Rushmore gave a graphic account of recent impressions of the work on the Isthmus. In connection with electrical matters Mr. Rushmore deprecated the fact that the power of the Chagres River had not been utilized in the canal construction under the administrations of Messrs. Wallace and Stevens. He praised the power-house construction at each end of the canal. A typical plant, containing three 1500-kw steam turbo-generators run from fuel oil, is used on the driving of cableway machinery at Gatun. A considerable amount of auxiliary work is also handled by electricity. Rotary converters are used to supply energy to the cableway motors, as these machines are all of the direct-current type. Mr. Rushmore also briefly described an electrically driven concrete mixing plant in which the material cars are operated by three-phase motors equipped for automatic operation between mixers. Two overhead trolleys are used, and the cars are run without anyone riding upon them. Power is very successfully returned to the line when the cars run on a down grade.

All the ships passing through the canal locks are to be hauled by electric locomotives, two in front and two behind. All the equipment of the locks is operated by electricity, including gates, main and auxiliary valves. A hydroelectric plant will be installed on the side of the spillway of the Gatun dam to supply energy for operation, the present steam plant being held in reserve. The lock gates are about 85 ft. long and weigh about 750 tons. The conditions for the operation of electrical machinery in the Canal Zone are very severe on account of the heat and moisture. It was unfortunate that the dredging was not handled electrically. Mr. Rushmore stated that the only thing on the Isthmus which he felt could be done better by air than by electricity was the operation of various drills. All the other work could have been done better by electric power than by any other agency. Two more men are required with a steam shovel than with an electric shovel, and the steam engines used are inefficient in the extreme. Electrically driven centrifugal pumps are also used in pumping earth for waterworks excavation. The electric locomotives used in hauling the ships through the locks will probably be operated by alternating current. Before closing Mr. Rushmore paid a high tribute to the work of Colonel Goethals and Colonel Gorgas. The esprit de corps of the entire organization is, he said, most commendable.

Telephone Growth in Chicago.

For the year 1910 the Chicago Telephone Company reports the greatest growth in its history, the net gain in the number of telephone stations being 37,641. In the City of Chicago the total number of telephone stations connected to the exchanges of this company now amounts to nearly 240,000, and in the suburban district there is something over 60,000, giving a total of about 300,000 stations in the territory served by the company. Studies for the future indicate a growth of about 30,000 stations a year for the City of Chicago, but these figures may be exceeded, as the 5-cent measured rate service, with a minimum of $1.50 a month, is popular with customers and is an important factor in the extension of the company's service.

It is of interest to consider the amount of wire used for telephone conductors in some of the large office buildings of Chicago. For example, in the People's Gas Building there are 335 miles of conductors; in the Commercial National Bank Building, 216 miles; First National Bank Building, 190 miles; Monadnock Building, 95 miles. These figures indicate the amount of plant required in the work of a telephone company in a large city. The mileage of wire in the buildings mentioned and in similar large buildings, and, indeed, all the interior mileage, is omitted in the general statement of mileage of wire installed in conduits and on poles throughout the city, which at the close of the year 1910 reaches a total of 551,553 miles.

Practical Electricity on the Farm.

The practical uses of electricity on farms and in farm residences were discussed at the recent convention of the National Gas and Gasoline Engine Trades Association at Racine, Wis. A paper on this subject by Mr. C. H. Roth, of Roth Brothers & Company, Chicago, opened the discussion and presented recommendations for the equipment of a typical farm installation of gasoline engine, generator and storage battery, to supply lighting, together with a small amount of motor service, about the farmhouse, barn and yard.

Farm owners are coming to recognize the convenience and other advantages of electric lighting, said Mr. Roth. Like the telephone, the rural free delivery and the automobile, electric light will soon be considered almost a necessity on progressive, well-managed farms. Electricity has the advantage over other illuminants of making available power for motor service as well as lighting, after the generating plant is once installed or lines brought in from a central station. To the tungsten lamp is due the credit for the remarkable impetus given successful farm lighting within the last year. Without the economy of consumption of the new lamp the cost of adding a storage battery to an isolated plant was almost prohibitive, and without a battery the engine and generator were required to run all the time that any lamps were in use, while their rating had to be large enough to carry the total demand of the lamps connected or used simultaneously. The generating equipment now employed with a battery need be only one-half of the possible demand, as battery and generator can be used in parallel to supply unusual loads.

Mr. Roth described a typical farm installation intended to supply thirty-four 16-cp and 8-cp, 30-volt tungsten lamps, operated an average of two hours daily. Complete with wiring and fixtures such a 0.5-kw plant, driven by a 1-hp engine, would cost about $500. To charge the 16-cell storage battery provided, running an average of one hour each day, or three hours at three-day intervals, and assuming gasoline to cost 15 cents a gallon and oil 5 cents a day, the total cost to operate the plant would be about $75 a year, made up as follows: Gasoline, $18.25; battery maintenance, $10; maintenance of engine and dynamo, $8; lamp renewals, $6; interest on investment, $28.20. This represents a total cost of less than 20 cents a day, or about ½ cent per lamp per day.

Electricity on the farm guards against the fire risk from lanterns and matches, more dangerous in the country than elsewhere; enables lamps to be controlled from a distance, and permits the farmer to do his wood-sawing, churning, cream-separating, pumping, corn-shredding, ensilage-cutting, threshing, hoisting, conveying, vacuum cleaning, washing, ironing, cooking, heating soldering and branding irons, and a hundred other operations, with the aid of electricity. In closing, Mr. Roth repeated Edison's prediction that the farmer of the future will spend his time at the switchboard during most of the day.

Mr. T. Milton, of the Electric Storage Battery Company, Chicago, told of the remarkable success of his company in disposing of farm isolated plants since it has assembled and offered for sale complete gas-engine-driven outfits. As soon as gas-engine dealers and farmers become properly interested in the possibilities of farm lighting the storage-battery company desires to withdraw from the sale of complete plants, devoting its efforts to the storage-battery equipment only. Popular advertising has resulted in bringing in thousands of inquiries, and the small-plant sales in the Chicago office of the company alone have jumped from one or two a month to four complete outfits each day.

Mr. E. P. Edwards, of the General Electric Company, Schenectady, N. Y., gave the estimate that out of this country's population, 92,000,000, only 26,000,000 people have access to the service of electric supply companies, which latter figure appears rather low. The 6,000,000 farms, therefore, offer the greatest industrial opportunity of the time for supplying them with electricity, and the farmer needs only to be shown the advantages of electricity and its ability to help him in his work. Mr. Edwards suggested that work should be done through the agricultural colleges in fitting students with a good knowledge of machinery, just as they are instructed in the raising of crops and live stock. For farm installations he suggests a standard potential of 110 volts in preference to 30 volts, where motors are to be operated, heating appliances used or lamps employed at some distance from the plant.

Mr. P. S. Rose, of Madison, Wis., pointed out that the regents of agricultural colleges must be encouraged to take a more progressive stand consistent with the increasing use of electrical and mechanical appliances on the farms, and should instruct students in these subjects.

The Promise of an Electrified Agriculture.

At the annual meeting of the American Society of Agricultural Engineers, held at Lafayette, Ind., Dec. 27 and 28, Mr. E. P. Edwards, of the General Electric Company, Schenectady, N. Y., read a paper on the subject of "The Promise of an Electrified Agriculture." The present decade, remarked Mr. Edwards, will be notable for its scientific agricultural development with the aid of electricity on the farm. As a class the farmer is a large user of power, but the sources from which he draws it are at present inefficient and uneconomical compared with industrial standards in other lines. As significant of the tremendous opportunities in the agricultural field, Mr. Edwards remarked that of the 29,000,000 persons engaged in gainful operation, reported by the 1900 census about 10,000,000 devote their energies to the farm. About 80 per cent of the horses and mules in this country are also at work on the farms. The farmers use more implements and a greater variety of mechanical devices than any other class, and it is important that they should be properly trained in the selection and use of this apparatus. No sharp line of division exists between farm and urban power needs, and mechanical and electrical power should benefit the farmer as well as the city man. But at present, in the farmer's ignorance of power apparatus and the machinery manufacturer's ignorance of farm methods and needs, neither seems to know just where this power should be applied.

Mr. Edwards spoke of the increased efficiency and economy of electric lighting since the advent of the tungsten lamp. For a few hundred dollars, he said, an isolated gasoline-engine-driven generator and storage battery can be purchased, and at the expense of a few hundred dollars more motors can be operated for running milking machines, cream-separators, churns, feed-grinders, threshing machines, hay-hoists, pumps, root-cutters, refrigerating outfits, corn-shellers, vacuum-cleaners, sewing machines, etc. Attention was called to the limitations of 30-volt direct-current plants where the operation of motors or heating appliances was desired, especially at any distance from the generating plant. Where isolated farm plants are being installed Mr. Edwards suggested that these be of the alternating-current type, employing a frequency common to the neighborhood central-station lighting plants, so that in case transmission lines were brought near the farm the isolated prime-mover apparatus, could be discarded and energy obtained from the central-station service. In closing, the speaker referred to the utilization of high-potential electricity for stimulating plant growth directly, and for the production of nitrogenous compounds used as fertilizers.

In the discussion which followed Mr. M. L. King, of Iowa State College, Ames, Ia., told of the use of electricity on several farms in northern Iowa, and Mr. O. H. Caldwell, of the *Electrical World*, described several central-station extension systems in central Illinois, from which electricity is being sold to farmers at the same low rates as in the neighboring towns. In reply to Mr. Edwards' remark that a single gasoline-engine outfit with electrical generator and motors was obviously better than half a dozen separate small engine outfits used for pumping, feed-grinding, threshing and other power purposes, Prof. J. B. Davidson, of the Iowa State College, at Ames, declared that a careful investigation of farm conditions had convinced him that electricity was suitable only for lighting on the farm and that motors with their connecting wiring were unsatisfactory for the portable work required. Gas-engine energy at 2 cents a hp-hour represented also a great saving, he said, over electrical energy at even 10 cents per kw-hour. In his own experience he had found it cheaper to grind feed with gas-engine power than with electricity at 5 cents per kw-hour, a rate lower than service could be supplied to most farmers. Mr. Edwards mentioned the gas-electric tractor for farm use, with its four-wheel drive by motors at each axle, energized by a gasoline engine, and suggested that a unit of this kind might be of service for lighting duty, in connection with a storage battery to supply energy for small demands while the tractor outfit was employed at other work.

"Agricultural Engineering and the Demand for Agricultural Engineers" was discussed by Dr. Samuel Fortier, chief of irrigation investigations of the United States Department of Agriculture. In the sixty-seven land-grant colleges of this country, which have permanent equipments valued at $112,000,000 and total annual incomes amounting the $18,000,000, 24,930 of the 27,579 students are classified as follows:

Engineering	17,892
Agriculture	4,999
Household economy	1,443
Forestry	223
Veterinary science	215
Horticulture	158
Total	24,930

These figures show that the land-grant colleges are engineering rather than agricultural schools, and that they are training almost 60 per cent of the engineering students of the country. Attention is chiefly given to training civil, mechanical and electrical engineers, while only two colleges out of the sixty-seven have established courses in agricultural engineering. The need and demand for the agricultural-engineering work indicate that the course should be divided into six sections:

1. Farm machinery and farm motors.
2. Farm structures, including rural architecture.
3. Rural water supplies and sanitation.
4. Public roads.
5. Drainage.
6. Irrigation.

This course should be supplemented by general instruction in the elements of a well-rounded education.

Each year more than $100,000,000 is expended for farm implements and machinery, and in the purchase of this great quantity of apparatus the best of judgment should be employed. Farm architecture also needs improvement, and the simple problems of water supply and other farm chores should be made less laborious and more sanitary. The problem of good roads imperatively calls for solution when it is known that the average American farmer pays 23 cents to haul a ton a mile, although 10 cents should cover the cost on improved highways. The reclamation of waste areas through irrigation of unwatered lands and the drainage of swamps is another great and useful field for the engineer's knowledge and skill. At least 230,000,000 acres of waste swamp land await reclamation in the United States. Two-fifths of the area of this country is arid, and much of the remainder is subject to periodical droughts which make artificial watering necessary to farming operations.

The land-grant colleges have long been catering to the de-

mand of the industrial and municipal organizations for civil, mechanical and electrical engineers, said Dr. Fortier, and unless the curricula in these schools are changed the older branches of the engineering profession are sure to be overcrowded. Meanwhile progress in agriculture and the improvement of rural districts are being immeasurably retarded through the lack of competent agricultural engineers.

Gasoline Lighting Installation Causes Serious Explosion and Fire.

A gasoline explosion in a poolroom on the lower floor of the two-story building at 919 Pine Street, St. Louis, about 8:30

Fig. 1—Front View of Building.

a. m. on Nov. 12, caused a fire which resulted in damage estimated at $50,000, principally to the school for the instruction

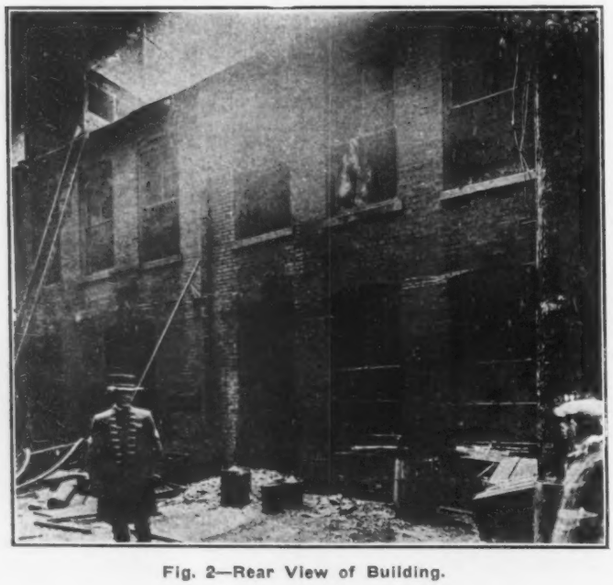


Fig. 2—Rear View of Building.

of maintenance men, which had just been established on the upper floor by the Bell Telephone Company of St. Louis. The poolroom on the ground floor was occupied by a Greek and was lighted by gasoline, the latter being conducted to fixtures over the pool tables and elsewhere by tin pipes connected to a tank. By a leak or in some other manner there was an explosion of gasoline fumes. The gasoline caught fire and a large quantity of the burning fluid spread all over the building, and in an instant the whole interior was ablaze. The occupants of the building had to run for their lives.

There appear to have been two explosions. A policeman who was passing heard a slight noise and saw smoke. He stepped up to the poolroom window and peered in. The next instant the plate-glass front was blown out and the 200-pound man was hurled into the middle of the street, sustaining painful but not dangerous injuries. The fire burned with great intensity owing to the gasoline, but the firemen saved the walls of the building. The accompanying illustrations are front and rear views of the building, after the fire, taken before the firemen had left. The rear view shows some cans, which are apparently gasoline cans.

On the second floor of the building, and extending into an adjoining building, was the school of instruction of the maintenance department of the Bell Telephone Company. Twenty young men who are learning the work of installing telephones had just reached the rooms and were preparing to start in on the duties of the day when the explosion came. They were forced to flee without their overcoats. The principal financial loss occurred here, because the telephone company had a large number of new telephones stored in this place.

Wisconsin Commission News.

The Gogebic & Iron Counties Railway & Light Company has been recently organized for the purpose of acquiring the stocks and bonds of the Gogebic & Iron Counties Railway & Light Company, of the State of Michigan, which company owns the electric light plant at Bessemer, Mich., and has an option contract on the property of the Twin City General Electric Company, comprising the street railway and electric light plants serving the cities of Ironwood, Mich., and Hurley, Wis. The new company plans also to acquire the property of the Ashland Power Company, which company owns the majority of the capital stock of the Ashland Light, Power & Street Railway Company and also owns land in Ashland County containing the Grand Canyon of Wisconsin, Copper Falls and Brownstone Falls. There is a total head on the Bad River, in this territory, of 150 ft.

It is the purpose of the company to improve the Copper Falls and Brownstone Falls property. The survey made in this connection showed that by the acquisition of another piece of property, known as Mellen Rapids, a total fall of 258 ft. could be made available. This property has been subsequently acquired, together with very liberal flowage rights. The company intends to improve these various water-powers and to connect them up with the White River Power Company's plant at White River, owned by the Ashland Light, Power & Street Railway Company, by transmission lines, and to connect the same to Ironwood and Bessemer, Mich., so as to distribute this power throughout the territory named and thereby serve the demand of the various mining companies along the Gogebic range for cheap electric energy.

The company has petitioned the commission for authority to issue stock and bonds as outlined below, which authority the commission has granted. The authorized issue consists of the following:

(1) Two thousand shares of preferred stock of the par value of $100 each, carrying a guaranteed dividend of 6 per cent per annum, being a total issue of $200,000. This stock is to be sold for money only and for not less than par value. (2) Five thousand shares of common stock of the par value of $100 each, being a total issue of $500,000. This stock must be sold for money only and for not less than par. (3) Gold mortgage bonds, to the sum of $1,344,400, par value, to bear interest at the rate of 5 per cent per annum and to be secured by a

mortgage or deed on all the property of the company. The bonds are to be sold for money only and for not less than 75 per cent of the par value.

The commission specified that the funds to be derived from the sale of the foregoing stock and bonds must be used for the following purposes:

(a) Purchasing bonds of the Ashland Power Company of the par value of $120,000. (b) Developing water-power on the Bad River, near Mellen, Wis., constructing the necessary buildings and installing the necessary machinery. (c) Constructing a transmission line from the power plant of the Ashland Light, Power & Street Railway Company at White River and at Brownstone Falls on Bad River, to the City of Hurley, Wis. (d) Purchasing the first-mortgage bonds of the Iron Counties Railway & Light Company, of the State of Michigan, of the par value of $458,300. (e) Purchasing 500 shares of 8 per cent preferred stock and 500 shares of the common stock of the Ashland Power Company. (f) Purchasing a reservoir system and building storage dams. (g) Providing the necessary working capital and to pay interest, incidentals and contingencies during construction. (h) Purchasing 3500 shares of the common stock of the Gogebic & Iron Counties Railway & Light Company, of the State of Michigan.

The Lancaster Electric Light Company petitioned the commission for authority to put into effect a minimum charge of $1. After investigating the conditions in Lancaster the commission allowed the company a minimum charge of 75 cents.

Maryland Commission News.

The Maryland Public Service Commission has withheld action on the application of the Park Heights and Mortimer Heights Water Companies to merge as a suburban water company. Necessary to the plan was the consent of the commission to an issue of $90,000 in bonds and $120,000 in stocks to cover the cost of the purchase of both properties and provide funds for subsequent extensions. The commissioners said that if it was impossible for the transaction to go through on the basis of anything less than the immediate issue of $90,000 of bonds and $120,000 of stock for the property as it stands then the application must certainly be denied. The commission did not sign an order to that effect and will not do so until the applicants have had sufficient time to present the matter in a revised form. The commission, after thoroughly investigating the financial situation and going into the assets of both companies, as well as into the revenue that it would be possible to derive from such a merger, gave a hint as to what it might consider a fair issue of bonds and stock. The opinion prepared by the commission was a long one and included the results of an investigation made by its chief engineer, Mr. Charles E. Phelps, who not only reported to the commission on the physical value of the property concerned, but made a study of it with a view to ascertaining its prospects after the merger had been effected.

Mr. George H. Bausman has asked the commission to inquire into a contract that he said was about to be made between the Consolidated Gas, Electric Light & Power Company and James L. Kernan for lighting his buildings on North Howard Street with electricity. It was alleged that the contract called for energy at 1 cent per kw-hour, whereas the actual cost was about 2 cents per kw-hour. Such rates, he said, were a discrimination. It was pointed out in the letter that Mr. Kernan had a private lighting plant. The company, it was said, desired to put all such plants out of commission and, in order to do so, rates were made below cost, and the public generally would have to pay the expense involved in suppressing private plants. Mr. Bausman says he is an engineer and the closing out of private plants would put him out of business.

The commission is investigating the subject of crowded street cars with a view to devising some method whereby the conditions may be relieved.

New York Commission News.

The Fulton County Gas & Electric Company, through its manager, Mr. J. E. Hodgson, has voluntarily reduced the price of gas in the Cities of Johnstown and Gloversville from $1.30 per 1000 cu. ft. to a sliding scale of prices commencing at $1.20 and running down to $1 per 1000 cu. ft.

The application for permission to change the rates, when submitted to the Public Service Commission, Second District, was immediately granted. The reduction comes at this time without any request from the citizens of these cities, and no complaint as to price had been submitted to the Public Service Commission. The application was presented by G. W. Curran, Comptroller of the United Gas & Improvement Company, of Philadelphia, which controls the Fulton County company.

The Public Service Commission, Second District, has ordered a conference to be called of the general managers, district superintendents, train dispatchers and master mechanics of the several interurban railroads in the State, to be held at Syracuse on Jan. 19, for discussion of all questions in relation to the safety of operation of these railroad companies.

The attention of the commission has been called to a number of serious accidents on interurban railroads (nearly all outside of the State of New York, but involving conditions existing in this State), which accidents, as far as investigations have developed, were caused by defective methods of operation, defects in block signals or violations of rules or orders.

The electrical expert of the commission, Mr. Charles R. Barnes, is preparing a program of subjects which will be assigned to various interurban electric railroad officials for discussion at this conference to the end that all necessary precautions shall be taken and improvements made to prevent such accidents as have occurred in other States.

The Hoosac River Electric Light & Power Company has been authorized to exercise a franchise granted by the Town of Pittstown for furnishing electricity for light, heat and power.

The commission has received a complaint from J. H. Van Duzer & Company, of Newburgh, directed against the toll charge made by the New York Telephone Company between Newburgh and Tuxedo Park. The complainant has no alternative but to pay the 25-cent charge between Newburgh and Tuxedo whether he secures the party desired or not. He is obliged to call by number and take his chances as to whether his correspondent can be reached by that number. The company has been asked to answer the complaint within twenty days.

At the close of business for 1910 the Public Service Commission, Second District, had had presented to it for action 2071 different matters. These included 1438 complaints which were handled informally by the commission and settled without the necessity of formal orders, 371 formal complaints and 262 applications from various corporations for authorization by the commission. During the year the commission disposed of and closed 1670 of the matters presented. During the three years of the commission's existence 5496 matters have been presented to it for action. In addition to daily sessions and consideration of disposition of cases the commission handled 554 hearings, covering a period of 196 days.

During the year the commission authorized capitalization to the amount of $151,048,108. In 1909 there was authorized $142,855,035.85; in 1908, $92,253,900; for the last six months of 1907, $17,730,745.49, a total for the three and a half years of the commission's existence of $403,887,789.34.

During the present week the commission will hear the application of the Syracuse Rapid Transit Railway Company for authority to increase its capital stock from $4,000,000 to $5,750,000, the increase, $7,750,000, to be preferred stock, and for authority to issue and sell capital stock to pay outstanding notes amounting to $1,660,000; the application of the New York State Railways for authority to acquire capital stock of the Syracuse Rapid Transit Railway Company; and the application of the East Hampton Electric Light Company for authority to issue $14,000 in first-mortgage 6 per cent bonds.

The Public Service Commission, Second District, has entered

an order, effective Feb. 1, 1911, prescribing rules and regulations to govern after that date the practice of gas and electrical corporations and exacting cash deposits from consumers. Correspondence received at the office of the commission has disclosed that many patrons of such corporations are ignorant of the provisions of law pursuant to which such deposits are exacted. Accordingly an inquiry was made by the commission into the practice, disclosing an entire absence of such proper rules upon the part of the corporations that the observance of them would inform the depositor as to his rights in the transaction and safeguard his interests. The order is designed to correct these conditions. The more important provisions of the order are as follows:

1. A detailed record shall be kept with respect to each deposit now on hand or hereafter received.

2. Upon each deposit shall be allowed and paid interest at the rate of 6 per cent per annum.

3. Each depositor upon ceasing to be a consumer shall have the right to withdraw his deposit and all accrued interest thereon upon certain terms and conditions.

4. Each corporation shall keep on hand for distribution to its customers printed circulars under its corporate or business name, such circulars to contain for the information of the depositors in full Section 63 of the Transportation Corporations Law, pursuant to which the companies obtain their rights in the matter, and shall also contain in full this order of the commission.

5. Each corporation shall on or before March 1, 1911, provide every consumer having a deposit with a copy of such circular and hereafter prior to exacting a deposit such corporations shall present a copy of said circular to the consumer or applicant for service of whom a deposit is demanded.

6. Also each corporation is required to provide reasonable ways and means whereby a depositor who in good faith makes application for the return of his deposit and is entitled to the return of same, but who is unable to produce the original certificate of deposit, may not for that reason be deprived of his rights.

AMERICAN ELECTRICAL ENGINEERS.

W. H. Powell.

William H. Powell was born in Leicester, England, Sept. 14, 1867, but was brought to this country by his parents when about three years old. His early life was spent in New Britain, Conn., where he received his primary education. After being graduated from high school he served as an apprentice in one of the local machine shops. While there an interest along engineering lines was awakened and he decided to make his career that of an engineer.

In 1886 he entered Cornell University, where he studied mechanical engineering under Dr. Thurston and electrical engineering under Prof. H. J. Ryan, and was graduated in 1890 with the degree of M.E. In conjunction with Mr. C. B. Humphrey, Mr. Powell made quite exhaustive studies of the efficiency of transformers, about which comparatively little was generally known at that time. The results of these investigations were embodied in their thesis, which was also presented in 1890 as a paper before the American Institute of Electrical Engineers.

Upon leaving college Mr. Powell entered the laboratory of the Westinghouse Electric & Manufacturing Company, where he took advantage of the opportunity to study closely the apparatus that came under his notice. After a few months Mr. Powell accepted a position as construction engineer with the North American Construction Company, in which position he was in charge of street railway work. While with this company he helped build the first Westinghouse electric road to be started, that at Greensburg, Pa. From this position he entered the New York district office of the Edison General Electric Company and became connected with the extended street railway work which was then being started. An opportunity to be associated with Prof. W. A. Anthony led Mr. Powell to accept employment with the Mather Electric Company, where he held the positions first of chief draftsman and then of superintendent. While with this company, under Prof. Anthony's direction, he designed the generator and motor equipment of one of the first 500-volt, direct-current, motor-driven manufacturing plants in the country, that of the Blatz Brewery in Milwaukee, which is still in operation with the original motors.

In 1894 Mr. Powell left the Mather company to become instructor in charge of the department of electrical engineering at Lehigh University and was one of those who helped to found the electrical engineering department of this university on a

W. H. Powell.

firm basis. He left the university after a year to become superintendent of the incandescent-lamp department of the Perkins Electric Switch Manufacturing Company.

In 1896 Mr. Powell was made chief engineer of the Keystone Electric Company, of Erie, Pa. He held this position and that of consulting engineer of the company until 1902. During this period, in 1900-1901, he returned to Cornell and took up graduate work, receiving the degree of master in 1901. His research covered particularly the design of rotary converters. Mr. Powell's work in the university led to his election to the honorary society of Sigma Xi.

In 1902 Mr. Powell became connected with the Crocker-Wheeler Company, of Ampere, N. J., where he began his work in multiple-voltage speed control. The major portion of his work with this company was as an industrial engineer working out practical methods and increasing the scope of the applications of electrical power. In 1904 he entered the Allis-Chalmers Company as engineer in charge of the direct-current motor department of the Bullock Works. This position he held until 1907, when he was made general superintendent of the Cincinnati works. In 1908 he was advanced to the position of engineer in charge of the electrical department of the Allis-Chalmers Company, in which position he now has complete supervision of all the electrical work.

During his work Mr. Powell has taken out a large number of patents. These deal with switches, circuit-breakers, controllers of various kinds, including multi-voltage controllers, direct-current motors and details of construction of various electrical apparatus, including both direct-current and alternating-current generators.

Mr. Powell is a member of the American Society of Me-

chanical Engineers and a member of the American Institute of Electrical Engineers, being chairman of the Milwaukee branch of the latter and a member of the committees on sections and on electric lighting.

CURRENT NEWS AND NOTES.

Electric Mill Power in North Carolina.—In a State report recently issued 655 factories are reported as operating in North Carolina, with an aggregate capital of $50,000,000. Electric energy is used exclusively in 110 factories and partly in thirty-three factories.

Heavy Maximum Load.—During the year 1910 the maximum load on the system of the Commonwealth Edison Company, Chicago, reached 182,600 kw early in December. For the year 1909 the corresponding figure was 158,090 kw, showing the satisfactory increase of 15 per cent.

Electrical Section, Western Society of Engineers.—Officers for the Electrical Section of the Western Society of Engineers, Chicago, have been named as follows: Chairman, Garrett T. Seeley; vice-chairman, J. R. Cravath. The retiring chairman of the section, Mr. George H. Lukes, was made a member of the executive committee.

Minneapolis Electric Show.—As previously announced, the Northwestern Electric Show Association will hold its second annual electric show in the National Guard Armory, Minneapolis, on Jan. 26 to Feb. 4. Many attractive features are promised, including a high-frequency demonstration by Mr. H. T. Plumb. Mr. R. W. Clark, 15 South Fifth Street, Minneapolis, Minn., is general manager for the show.

Exchange Lectures.—The colleges of engineering of the University of Illinois, Urbana, Ill., and Purdue University, Lafayette, Ind., arrange each year a series of exchange lectures delivered by the members of the faculty of each institution. The first lecture delivered at the University of Illinois this year under this plan was by Prof. C. R. Moore, of Purdue, on "Power Manufacture and Its Dangers."

A Marked Improvement in Load Factor.—For the year 1910 the load factor of the Commonwealth Edison Company, Chicago, was a little over 41 per cent. In 1900 it was slightly under 29 per cent. This improvement accounts in a large degree for the prosperity of the company, as it is undoubtedly true that the load factor is the controlling element in the making or losing of money by an electric service corporation.

Christmas Turkeys for Central-Station Employees.—Before Christmas the Commonwealth Edison Company, of Chicago, distributed about 2100 turkeys as presents to all employees, whether married or single, men or women, who had been in the company's service over one year. The North Shore Electric Company, of the same city, also gave a turkey to each employee who had been with the company six months or more.

An Unsuspected Source of Gas Poisoning.—According to press dispatches from Paris, Professor Courmont, of Lyons, addressing the French Academy of Medicine at a recent meeting, said that unperceived escape of carbon monoxide from gas pipes and gas-heating apparatus is the cause of many deaths resulting from gradual poisoning of the blood. The French government is urged to take measures to meet this danger.

Franchise for Telharmonium.—The New York Cahill Telharmonic Company has applied for a franchise for furnishing music through the medium of electrical conductors throughout New York City. The telharmonic system was described in our issues for March 10, 1906, Jan. 5, 1907, and April 28, 1910. The Bureau of Franchises has suggested that the initial term be twenty-five years, with the privilege of renewal for a further term of twenty-five years.

Commonwealth Edison Branch, N. E. L. A.—The next meeting of the Commonwealth Edison branch of the National Electric Light Association in Chicago will be held at 8 p. m. on Jan. 10 at Recital Hall, in the Auditorium, on Wabash Avenue, near Congress Street. Mr. P. B. Juhnke will read a short paper on "Generating and Transmission Systems and Load Dispatcher's Office," and Mr. A. E. Evans will have a paper on "Substations and Distributing System."

The Moral Is Obvious.—A South Side woman in Chicago met her death during the Christmas holidays in an unusual manner. A wreath of holly was hung on a gas fixture in her bedroom. The gas cock was loose and turned very easily, as is often the case. During the night of Dec. 24 the wreath was jarred loose from its support and in falling it struck the handle of the valve, opening it and allowing the gas to pour into the room. On Christmas morning the woman was found dead.

Pittsburgh, A. I. E. E. Meeting.—The December meeting of the Pittsburgh Section of the American Institute of Electrical Engineers was the best attended of the season, 125 persons being present. The subject was "Electric Lighting and Luminous Efficiency." Dr. E. P. Hyde presented a paper on "A Study of the Electric Incandescent Lamp," and Mr. F. R. Fortune one on "Luminous Efficiency as Affected by the Quality of the Light." Mr. C. F. Scott and others took part in the discussion.

Practical Way of Selecting Convention Topics.—Mr. Thomas Crawford, of Clinton, Ia., president of the Iowa Electrical Association, is sending out return postcards to members asking them to indicate what subjects they wish discussed at the convention in Davenport next April. Further, they are requested to name members whom they would like to hear on any subject connected with the industry. This appears to be a sensible plan to make a convention program of more practical value.

Columbia University Deutsches Haus.—As the result of the gift of $30,000 from Mr. Edward D. Adams for the purchase of a building for the purpose a "Deutsches Haus" is being established at Columbia University. The Deutsches Haus will contain a well-selected reference library and will serve as a bureau of information concerning schools and universities in both Germany and America. A gift of $100,000 has been obtained from an anonymous contributor as a permanent fund for the maintenance of the house.

Sits on "Deadly" Third-Rail.—The Trenton *Times* gives an account of the experience of a six-year-old boy with what it calls "the deadly third-rail." The father was horrified to see the child playing between the rails of the West Jersey & Seashore Railroad at Pitman, N. J., and commanding him to stand perfectly still, ran to the station for help. The newspaper continues: "But the boy got tired of standing, and when his rescuers arrived he was sitting calmly and squarely on the third-rail with thousands of volts of electricity passing under him."

Tantalum Lamps for Street-Car Lighting.—The Chicago City Railway Company is equipping all the cars in its extensive system with 16-cp series-burning tantalum lamps, each taking 2.3 watts per candle and connected to the 550-volt circuit. Twenty thousand of these lamps are already in place, and about 20,000 more will be needed, the lamps being purchased

through the sales department of the Commonwealth Edison Company, which supplies the company with its electrical energy. The Chicago Railways Company, as previously mentioned, is also using tantalum lamps after an exhaustive series of tests.

Electric Club of Chicago.—The meeting of the Electric Club of Chicago on Dec. 28 was devoted largely to an informal debate of the question whether the club should secure a more centrally located meeting place and possibly permanent quarters. Some elaborate plans were discussed. It was decided to enlarge the house committee, of which Mr. A. A. Gray is chairman, by adding to it Messrs. James H .Delany, George P. Nichols, C. A. S. Howlett and W. E. Keily. Out-of-town visitors at the meeting were Messrs. Robert Kelly, Jr., Holophane Company, Newark, Ohio, and H. A. Otterson, Ridgway Dynamo & Engine Company, Ridgway, Pa.

Measuring the Coasting Time of Street Cars.—Several St. Louis street cars have been equipped with a special coasting meter, or clock, which registers the total time during which energy is not taken by the motors. If this preliminary equipment is successful these instruments will be installed on a number of the cars. Other devices designed to encourage the motorman in the economical use of energy in starting and running have been constructed to register the total time during which energy is taken. The St. Louis idea employs the reverse principle and has a solenoid arranged to release the clock movement when no energy is passing through the controller.

Central-Station Vehicle Service in Chicago.—With its varied activities and widely scattered stations, substations and departments, the Commonwealth Edison Company, of Chicago, requires a number of vehicles for the transportation of men and goods, as well as tools and supplies. The transportation department, organized three years ago, has shown a remarkable growth under the management of Mr. C. F. Clark. It now has in its charge twenty-eight electric delivery wagons, thirteen gasoline automobiles and 123 horses and 118 horse-drawn vehicles. A large garage is maintained, and the calls for vehicles from various departments amount to about 600 a month.

"Wireless" from Aeroplanes.—A newspaper dispatch from Paris dated Dec. 24 says that Mr. Farnam has concluded the first of a series of experiments with wireless telegraphy used in connection with an aeroplane. The aviator is reported to have sent dispatches for a distance of six miles from an aeroplane in the air, and he is reported as being confident of being able in time to telegraph in this manner for a distance of sixty miles or more. The value of a practicable combination of wireless telegraphy and aviation in military maneuvers would be very great, and it is said that Mr. Farman's experiments have made a deep impression on the military experts of France.

Detroit A. I. E. E. Section.—At a recent meeting of electrical engineers held at the Hotel Tuller, Detroit, Mich., plans were formulated for the organization of a local section of the American Institute of Electrical Engineers. A list of twenty-five names, the number requisite to secure a charter, was secured and forwarded to the headquarters in New York. Messrs. H. M. Brown, John R. Woolfenden and A. T. Barley were chosen as a temporary committee to act until the completion of the regular organization. There are thirty electrical engineers in Detroit and perhaps twice that number in neighboring cities, and an endeavor will be made to get them all enrolled and affiliated with the profession.

Indiana Engineering Society.—The annual meeting of the Indiana Engineering Society will be held at Indianapolis, Jan. 12-14, at which several reports and papers on electrical subjects will be presented. The committee on central-station light and power, consisting of Messrs. Frank R. Daniel, chairman; C. D. Emmons and Prof. C. F. Harding will report on illumination costs, economy of motor-driven apparatus and protection of underground piping from electrolytic action. Reports will be presented by the committee on electrical engineering, Messrs. C. A. Tripp, chairman, E. H. Bangs and Robert P. Woods; and by the committee on electric railways, Messrs. Robert P. Woods, chairman, R. N. Murry and Thomas B. McMath. Mr. Chas. A Tripp will read a paper on individual drives applied to textile mills, and the Williams hydroelectric plant at Bedford will be described by Mr. DeWitt V. Moore.

National Independent Telephone Convention.—The annual convention of the National Independent Telephone Association, of which Mr. F. H. Woods is president, will be held at the Hotel Lasalle, Chicago, Jan. 17, 18 and 19. A number of important issues will be up for discussion, including the subjects of interchange of traffic with competing exchanges and regulation by State utility commissions, and a large attendance is expected at the meeting. The number of exhibitors this year will exceed that at any previous convention. The exhibits will be installed on the eighteenth floor of the hotel, while the convention sessions will be held on the floor above. The morning sessions are to be given over to discussions affecting the managerial and executive sides of the telephone business, while the afternoons will be devoted to technical discussions led by Mr. L. E. Hurtz, of Lincoln, Neb.

Electricity in the Modern Theater.—"We could not run this house without electricity," declared the manager of a large new theater recently. "I can scarcely enumerate the many ways in which we use electricity and we can only wonder how we ever got along without it." Not only is electricity used for the general illumination of the theater, but it is relied upon for stage effects of lighting, flame and fire, storm and crash, warmth and benignity, that are sometimes, with their easy or rapid gradations, fairly marvelous. The mechanisms of many important "acts" and illusions are entirely electrical; the call-boy has been superseded by electric signals from stage manager to dressing rooms, and heating and ventilation are controlled by electrical means. Even the scrubwomen are provided with baseboard attachments so that they can secure sufficient illumination in the portion of the building in which they are working without lighting the entire house.

Philadelphia N. E. L. A. Meeting.—The regular meeting of the Philadelphia Section of the National Electric Light Association was held Dec. 19 in the assembly room of the company building, 1000 Chestnut Street, with an attendance of 125 members and guests. Prizes were awarded to Messrs. W. H. Donley and J. J. Sessinger for securing the greatest number of new members during the season, and to Messrs. J. B. Seaman and W. L. Crist for the best suggestions relating to improvements in central-station management The suggestion of Mr. Seaman was to standardize the location of the house service and terminals for all makes of meters, and to adopt a standard coloring for terminals in order to facilitate their connection. The suggestion of Mr. Crist was the inclosure with each receipted bill of a slip expressing the company's thanks for the remittance and inviting continued patronage, a small advertisement being added. A revised constitution was adopted, which provides for the division of the section into branches, of which a meter department, an accounting department and a commercial department are already organized. Section meetings will be confined to a consideration of general topics. Two papers were presented at the meeting, one on "Business Getting," by Mr. J. E. Dougherty, and the other on "Refrigeration," by Mr. R. L. Lloyd. Dr. Spitzka will address the next regular meeting, to be held Jan. 16, on "The Effects of Electricity on the Human Body."

QUARRY STREET STATION COMPLETED.

The Latest Generating Plant of the Commonwealth Edison Company, with Continuous Rating of 84,000 Kw.

TWO years ago an article was printed in the *Electrical World* describing and illustrating the initial equipment of the Quarry Street generating station of the Commonwealth Edison Company in Chicago. Since then the entire station has been completed and placed in operation, and the purpose of this article is to describe the finished plant. To make the article complete there will be brief reference to the general arrangement, as described previously, but the greater portion of the present account will be devoted to the more recent equipment and to the purely electrical features of the station which have been worked out for the complete installation.

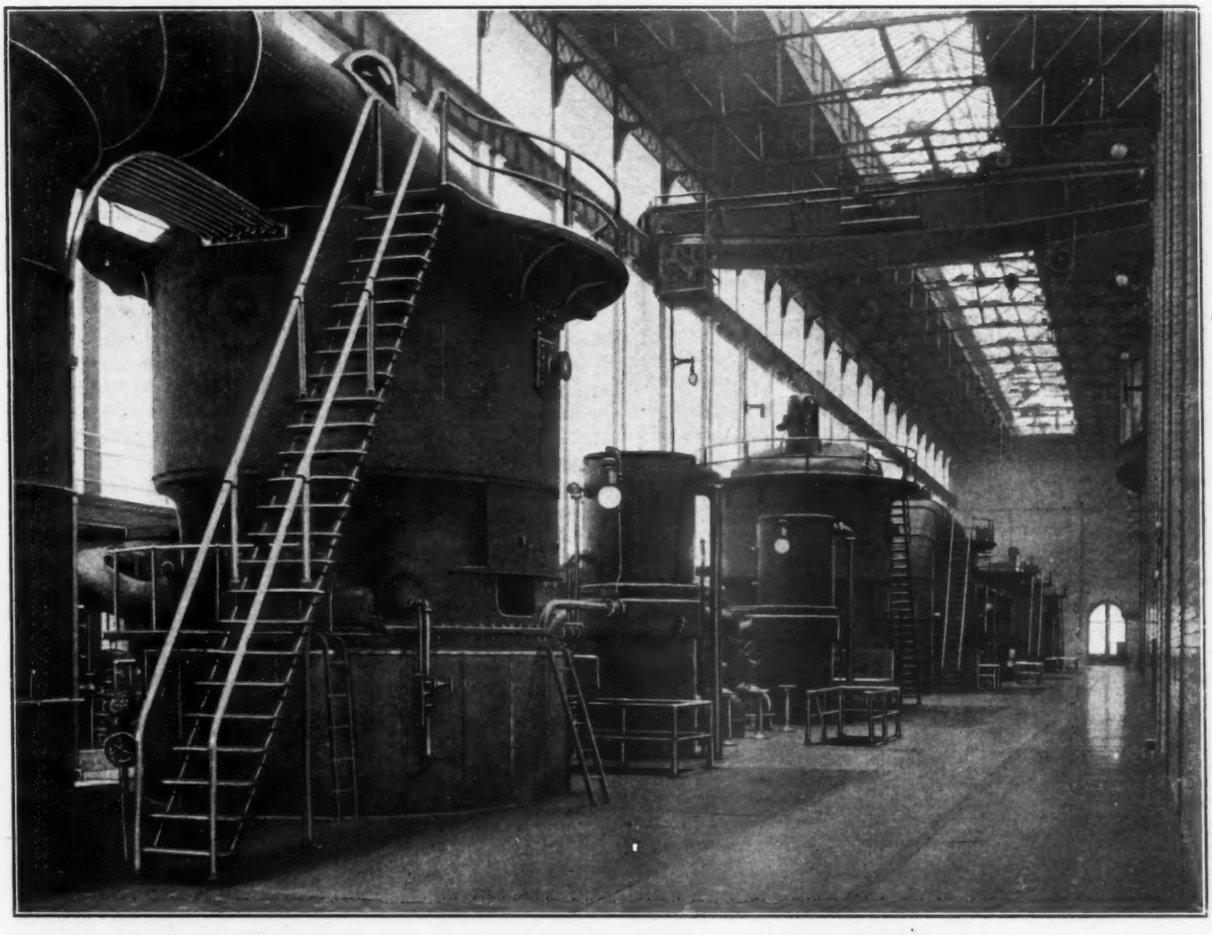


Fig. 1—View of Turbine Room Looking East.

Six generating units of 14,000 kw each, or 84,000 kw in all, are installed in this plant. Two of these constitute the initial equipment described in the preceding article. The four units added during the last two years have a combined rating of 56,000 kw. That this increase is demanded by the constant extension of the business of the Commonwealth Edison Company is shown by the fact that whereas in 1908 the maximum load on the company's system was 117,370 kw, the corresponding figure of two years later was 182,600 kw. During this period, also, the maximum rating of Fisk Street station, a near neighbor of the Quarry Street plant, was increased from 100,000 kw to 120,000 kw by the remodeling of four of the earlier generating units in that station. Furthermore, the company is now engaged in erecting a new station several miles distant from the Fisk and Quarry Street plants, to have a rating, when completed, of 120,000 kw, and to be followed by a duplicate station on the same plat of ground of a like rating. This new station is known as Northwest station, and when the two Northwest plants are completed they will add 240,000 kw to the generating capacity of the system. At that time the total rating of the four steam-turbine generating stations of the company will be 444,000 kw. The initial equipment of the first Northwest station will be 40,000 kw in two units (the largest yet built), and it is expected that these 20,000-kw machines will be in service by the close of the year 1911.

GENERAL ARRANGEMENT.

Quarry Street station is located directly across the South Branch of the Chicago River from its older and somewhat larger neighbor, the Fisk Street station. Fig. 2 is a property plat of the two stations, showing their relative position and surroundings. The two plants are quite distinct, so that a breakdown in one would not cripple the other, but they are electrically connected by tie lines in two tunnels and they are operated together as one electrical generating system. A ferry service is maintained across the river at this point.

The building of the Quarry Street station is a massive one, less ornamental than the Fisk Street station, yet dignified and imposing. The exterior is of red pressed brick, and the boiler room is surmounted by eight steel stacks. The building is 462 ft. 10 in. long, east and west, and 207 ft. 10 in. wide, north and south. The distance from the ground to the roof over the turbine room and boiler room is about 80 ft.

The station arrangement is longitudinal; that is, the plant is divided into four parts placed side by side, and each extending the entire length of the building. Each of the four divisions, therefore, is 462 ft. long. The four parts consist, in order from north to south, of the train shed, 27 ft. 6 in. wide; the boiler

room, 86 ft. 6 in. wide; the turbine room, 56 ft. 4 in. wide, and the switch house, 34 ft. wide. The train shed and the switch house are not as high as the central portion of the building, and in the case of the switch house there is a central pavilion for the operating gallery higher than the wings on either side, but still not reaching to the level of the roof of the turbine room. Fig. 3 is a good view of the exterior of the entire plant, taken from across the river, and showing the train-shed side. The principal entrance to the station is on the opposite side of the building and is shown in Fig. 4. Fig. 7 shows a cross-section and Fig. 8 a general arrangement plan of the whole station.

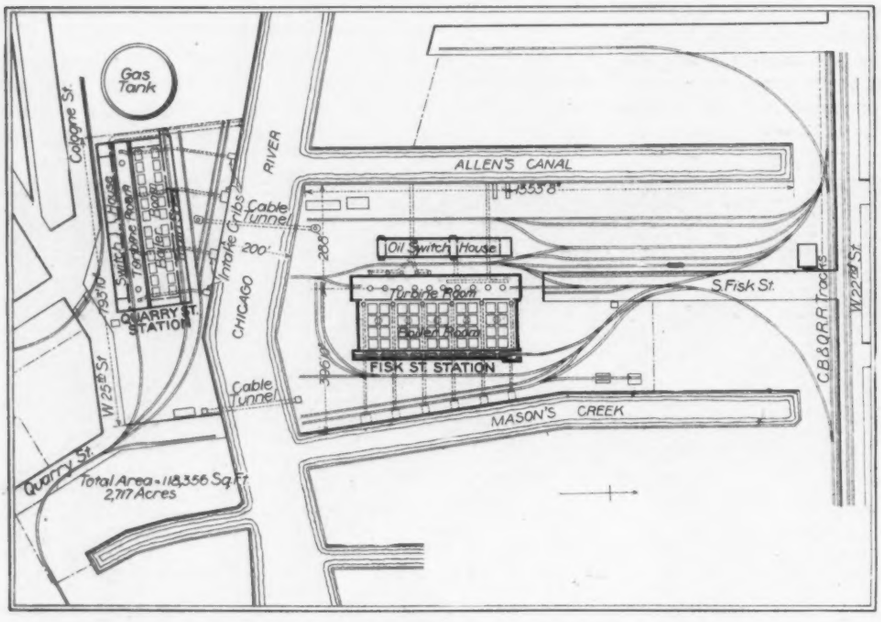


Fig. 2—Map of Property (Including Fisk Street Station).

Ample provision has been made for natural light and for ventilation. Skylights, monitors and side windows are used to admit the light and air, and window control is effected by electro-pneumatic means. The turbine room is finished in white-enameled brick, and owing to its length and the fact that it is over 60 ft. high it presents an impressive appearance. There is a visitors' gallery on the northern side of this room on the boiler-room level, and several doors open into it from the boiler room. A railroad track extends the whole length of the train shed and is used in the delivery of coal and the taking away of ashes. Another permanent railroad track is placed at the southern side of the turbine room.

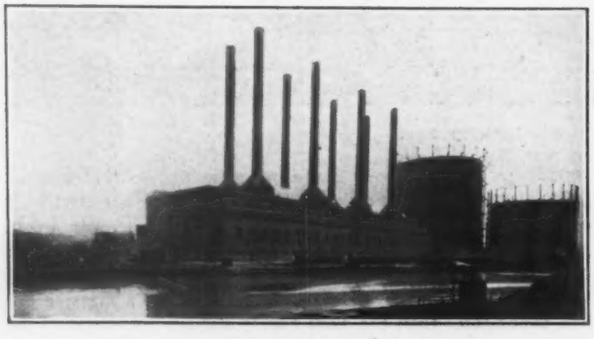


Fig. 3—View of Exterior from Riverside.

TRAIN SHED AND BOILER ROOM.

Coal is brought into the station in cars on the track in the train shed by means of the company's yard locomotives. Here, by means of overhead traveling cranes with grab buckets, the coal is dumped into hoppers beneath the track and in turn emptied into a longitudinal conveyor for each half of the station. Thus it is taken to crushers at each end of the train shed. Transverse conveyors carry the fuel to bunkers over the boilers, holding 150 tons for each individual boiler. The ash-handling system presents no novel features; it is similar to that at Fisk Street.

Arranged in two rows parallel to the turbine room are eight water-tube boilers for each generating unit, or forty-eight for the entire station. These boilers present a long and impressive perspective, as may be judged from Fig. 5. Each boiler has 5000 sq. ft. of heating surface, exclusive of the superheaters. The boilers are designed for 225-lb. gage pressure and for a maximum steaming capacity of 30,000 lb. per hour. The superheater is designed to give from 150 deg. Fahr. to 175 deg. Fahr. of superheat when the boiler is operated at 30,000 lb. of steam per hour. The automatic chain grates are 8.5 ft. x 11.5 ft. in the case of the boilers for the first two units and 9 ft. x 11.5 ft. in the case of all the other boilers.

The original boiler setting at Quarry Street represented a new departure in power-house design, as the furnace was placed under what is ordinarily the rear header of the boiler. This arrangement enables a decided improvement to be made in boiler efficiency, and with the long flame chamber, expanding in volume, it makes for more perfect combustion. However, on account of the comparatively high cost of maintenance of furnaces for the boilers with the horizontal pass the last six boilers to be installed in this station have been provided with standard settings, except that they were set at the same height as in the case of the "reverse" boilers which have just been mentioned. Thus the latest boilers installed also have a larger combustion chamber than is the case in ordinary practice.

Eight steel stacks, 12 ft. inside diameter and extending 250 ft. above the boiler-room floor, are provided. There are thus six boilers for each stack. The stacks are carried on steel structures over the boilers. A hand-power 5-ton crane is provided in the boiler room.

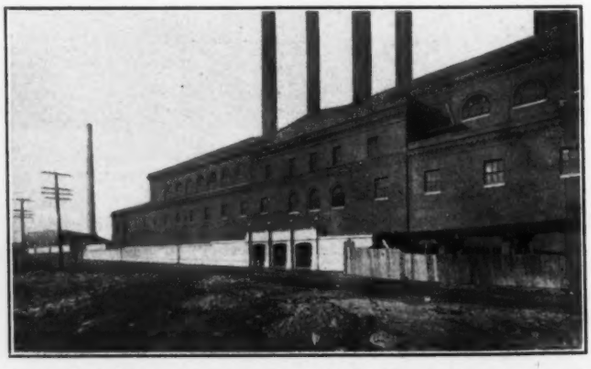


Fig. 4—Exterior from Switch-House Side, Showing Main Entrance.

TURBO-GENERATORS AND THEIR AUXILIARIES.

Extending down the center line of the turbine room is a row of six turbo-generator units with their auxiliaries. Each of these units has a continuous rating of 14,000 kw and is a com-

plete and individual unit, each with its own auxiliaries. The distance from center to center of these machines is alternately 67 ft. and 74 ft. Each steam turbine has an independent steam header and connections to the eight boilers which supply the steam, making each unit independent on its steam side. These headers are carried in an absolutely straight line. In addition there are cross-connections between adjacent sets.

Fig. 1 is a general view in the turbine room. As will be seen, the large ventilating ducts leading to the tops of the turbo-

Fig. 5—View in Boiler Room Looking East.

generators are a conspicuous feature of this plant. These ducts are connected to air chambers in the basement, provided with grated openings leading to the outside air, and as vanes are placed in the incased revolving-field cores of the generators air is drawn through these ducts to ventilate the generators. The heated air is forced downward and out through the laminations of the stationary armatures and rises to the top of the turbine room, where it escapes to the outer air by means of ventilating equipment, to which reference has already been made.

The generating units consist of five-stage Curtis steam turbines direct-coupled by means of vertical shafts to three-phase, four-pole, revolving-field generators. These generators are of two types—9000 volts at 25 cycles and 12,000 volts at 60 cycles, as will be explained later. The speed of operation is 750 r.p.m. and 720 r.p.m. respectively, and the machines stand about 25 ft. above the floor. Including the condensers in the basement, the entire height of each unit is 33 ft., while the diameter is 15 ft.

The condensers are set in the basement so that the operating parts of the turbine are conveniently reached from the main turbine floor. Each condenser has 25,000 sq. ft. of surface. Each unit is equipped with a combined circulating and vacuum pump driven by a Corliss engine. The pump is of the volute type and has a rating of 25,000 gal. per minute. The steam cylinder of this machine is 20 in. in diameter and the air cylinder 28 in., with 24-in. stroke.

Each unit is also provided with a turbine-driven hot-well pump, which is set in a pit in the basement floor next to the condenser. Also each unit has an independent vertical feed-water heater and a centrifugal, turbine-driven, 4-in., three-stage boiler-feed pump. A spare boiler-feed pump is provided for each two units, this being of the reciprocating type. It may be of interest to state that this is probably the first station in the United States in which centrifugal boiler-feed pumps have been installed. These pumps are proving very successful. A view in the turbine room designed more particularly to show the auxiliaries is given in Fig. 6.

A double oiling system is provided for each unit. One of the systems supplies the oil to the step bearings, and this is operated at about 1200 lb. pressure. The other system supplies oil to the upper and intermediate bearings of the turbo-generator and to the governor. An oil filter is placed on the turbine-room floor directly in front of each unit. The pumps for each of the two oiling systems are arranged in duplicate. An oil accumulator is also provided for each unit for regulating the oil pressure on the step bearing.

A color scheme is used to designate the different kinds of piping employed in the station.

The water intake is from four cribs which have been built in the river to provide for the station's requirements. Four tunnels lead from these cribs to intake wells in the turbine-room basement directly under the circulating pumps. The discharge from the condensers is fed into a well for each unit. Each of these wells is connected to a common discharge tunnel, which empties into the river at a point west of the station. This discharge tunnel is circular in section and 9 ft. 8 in. in diameter.

A 90-ton electrically operated overhead traveling crane equipped with four motors spans the turbine room.

ELECTRICAL ARRANGEMENT.

As already stated, the electrical output of Quarry Street station is of two kinds—9000-volt, 25-cycle energy and 12,000-volt, 60-cycle energy. Four of the six generating units—those known as Nos. 1, 2, 3, and 4—are 9000-volt, 25-cycle machines and two, Nos. 5 and 6, are 12,000-volt, 60-cycle machines. A 5000-kw frequency changer placed on the first floor of the switch house, with an opening leading into the main turbine room, forms the link between the two systems. This frequency changer enables the station to take advantage of the diversity factor between the 25-cycle and 60-cycle systems, the unit being used to feed into one or the other system as the conditions of load may require.

All energy from the 9000-volt, 25-cycle machines is delivered to the western end of the switch house, which contains the 9000-volt buses, switching equipment and outgoing lines. The two 12,000-volt, 60-cycle machines, together with the 60-cycle generator of the frequency changer, deliver all their energy to the newer, or eastern, section of the switch house, where the 12,000-volt buses, switching equipment and outgoing lines are located. At the present time the 9000-volt, 25-cycle part of the frequency changer is used ordinarily as a motor and drives the 12,000-volt, 60-cycle side as a generator. This arrangement may be reversed, however, when needed, as has been explained.

Referring to the diagram of general bus connections (Fig. 9), each generator, as shown, is connected through oil switches to an auxiliary bus and to a main bus. The main bus is sectionalized between units. Each unit has two line buses, and each line bus supplies four outgoing lines. Each line bus is connected to both the auxiliary bus and the main bus. This two-bus arrangement permits supplying energy from any unit to any group of lines.

The frequency changer, likewise, is equipped for eight outgoing lines, and these, with the eight lines from each generating

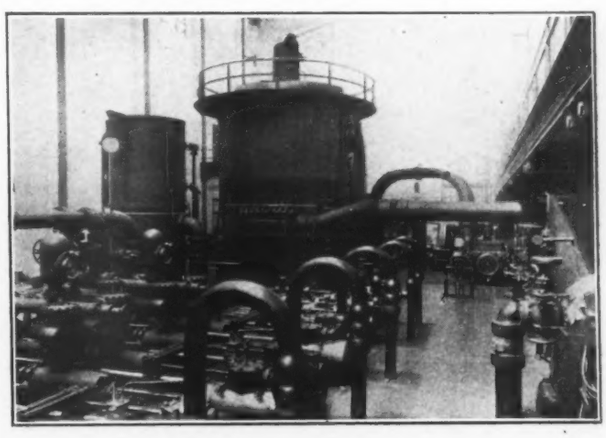


Fig. 6—View in Turbine Room, Showing One Unit and Auxiliaries.

unit, make up the total number of outgoing lines from the station, which is fifty-six. The 60-cycle side of the frequency changer has the same bus connections and outgoing-line equipment as is provided in the case of the generating units.

SWITCH-HOUSE EQUIPMENT.

In the basement of the switch house below the level of the turbine-room floor and next to the outside or southern wall is the high-tension cable vault. On the north side of the base-

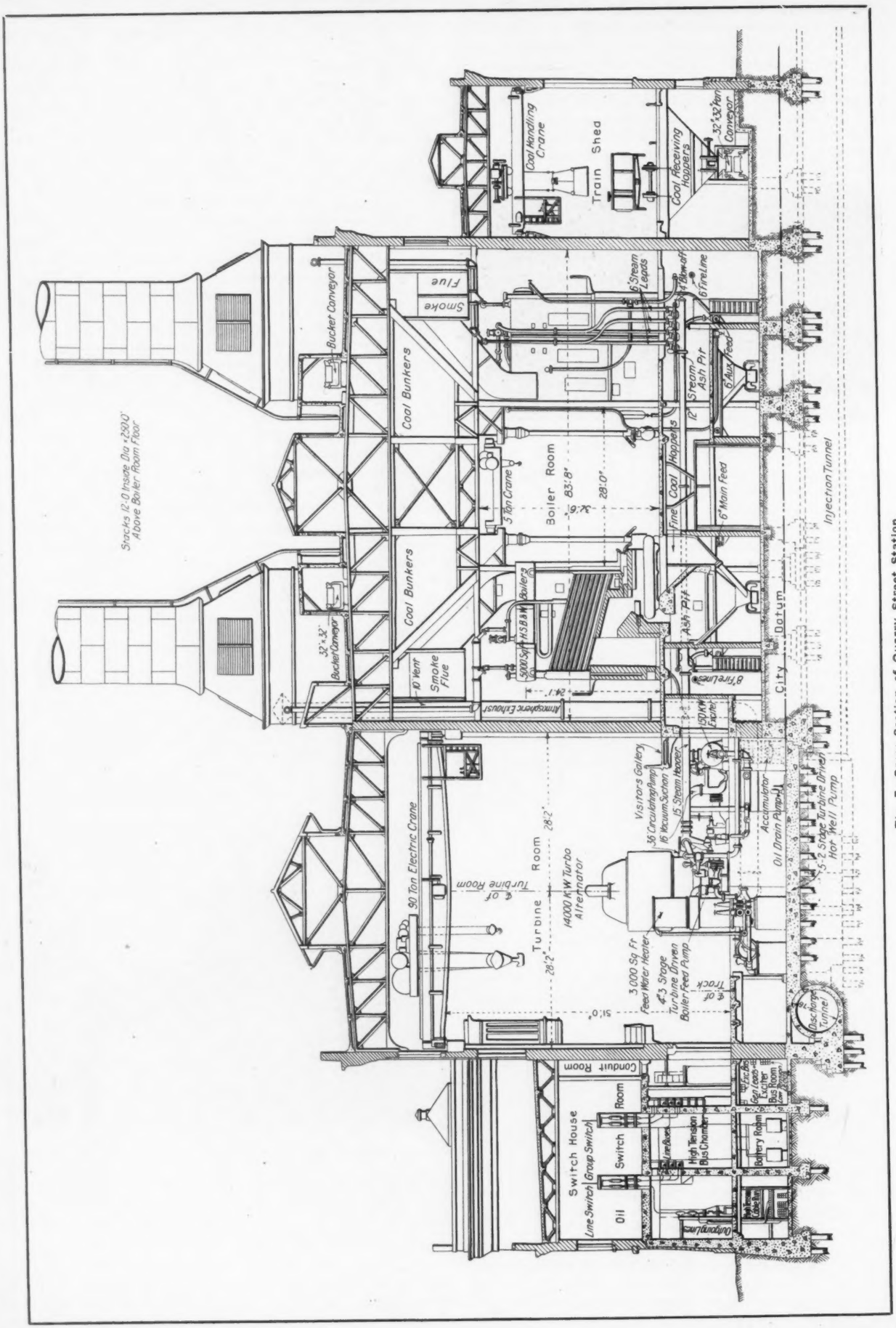


Fig. 7—Cross-Section of Quarry Street Station.

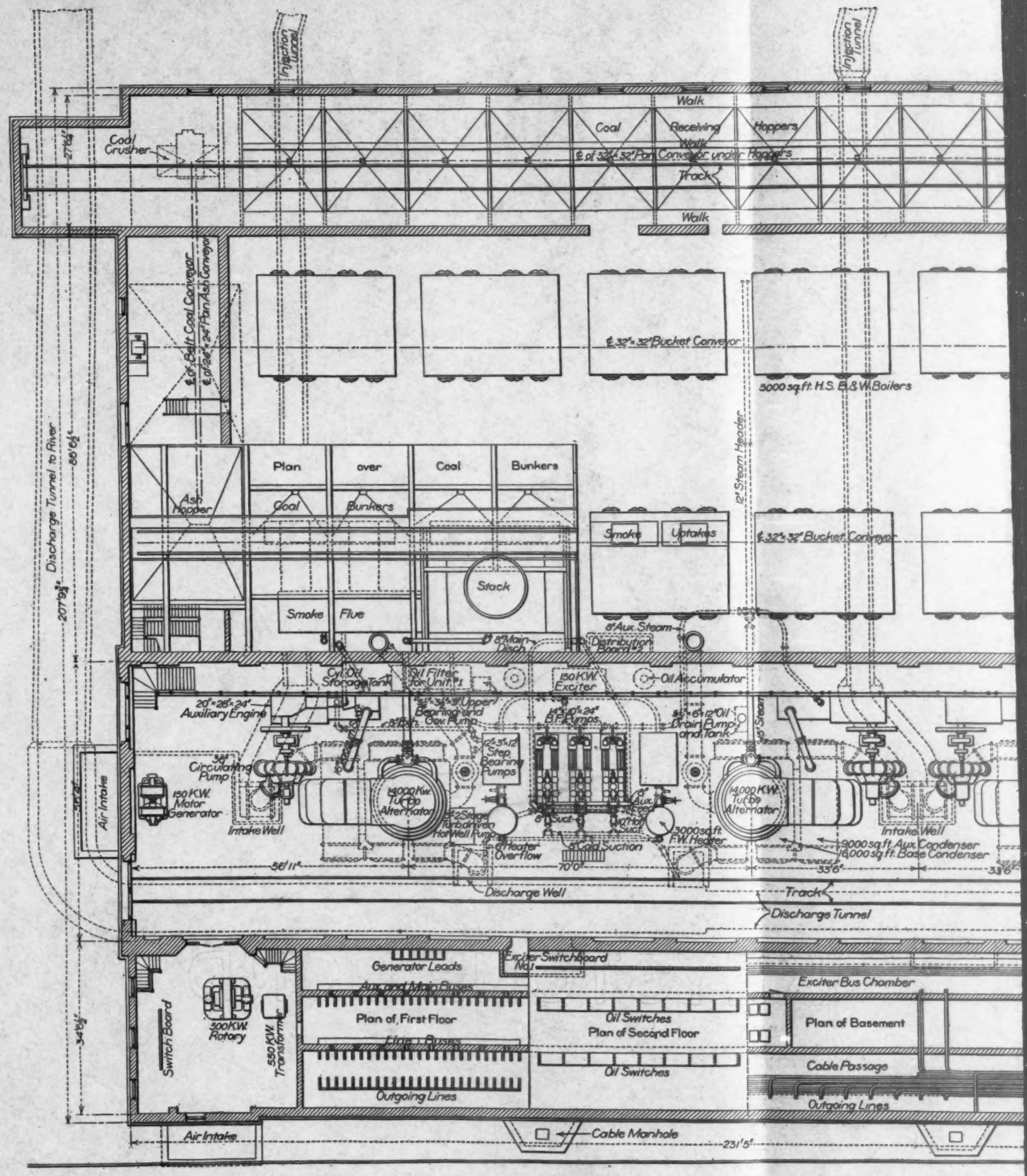

Injection Tunnel
Injection Tunnel
Walk
Coal
Receiving
Hoppers
Walk
℄ of 32"x 32" Par Conveyor under Hoppers
Track
Walk
Coal Crusher
27'6½"
℄ of Belt Coal Conveyor
℄ of 24"x 24" Pan Ash Conveyor
℄ 32"x 32" Bucket Conveyor
5000 sq ft. H.S. B.&W. Boilers
12" Steam Header
Discharge Tunnel to River
86'6½"
207'9½"
Plan over Coal Bunkers
Ash Hopper
Coal Bunkers
Smoke
Uptakes
℄ 32"x 32" Bucket Conveyor
Stack
Smoke Flue
8" Main Disch.
8" Aux. Steam
Distribution Board
Cyl. Oil Storage Tank
Oil Filter for Unit #1
150 K.W. Exciter
Oil Accumulator
20"x 28"x 24" Auxiliary Engine
8" Bath
14"x 10"x 24" B.F. Pumps
55"x 6½"x 12" Oil Drain Pump and Tank
8" Steam
34"x 9" Upper Bearing and Gov. Pump
2½"x 3"x 12" Step Bearing Pumps
36" Circulating Pump
150 K.W. Motor Generator
14000 Kw. Turbo Alternator
2 Stage Turbo-driven Hot Well Pump
8" Suct.
8" Aux. Exh.
8" Hot Suct.
14000 K.W. Turbo Alternator
3000 sq. ft. F.W. Heater
Intake Well
Intake Well
8" Heater Overflow
8" Cold Suction
9000 sq. ft. Aux. Condenser
16,000 sq. ft. Base Condenser
56'11"
70'0"
33'6"
33'6"
Air Intake
Discharge Well
Track
Discharge Tunnel
Generator Leads
Exciter Switchboard
Exciter Bus Chamber
Plan of, First Floor
Oil Switches
Plan of Second Floor
Plan of Basement
Switch Board
500 K.W. Rotary
550 K.W. Transformer
Cable Passage
Outgoing Lines
Outgoing Lines
Air Intake
Cable Manhole
231'5"
34'6½"

Fig.

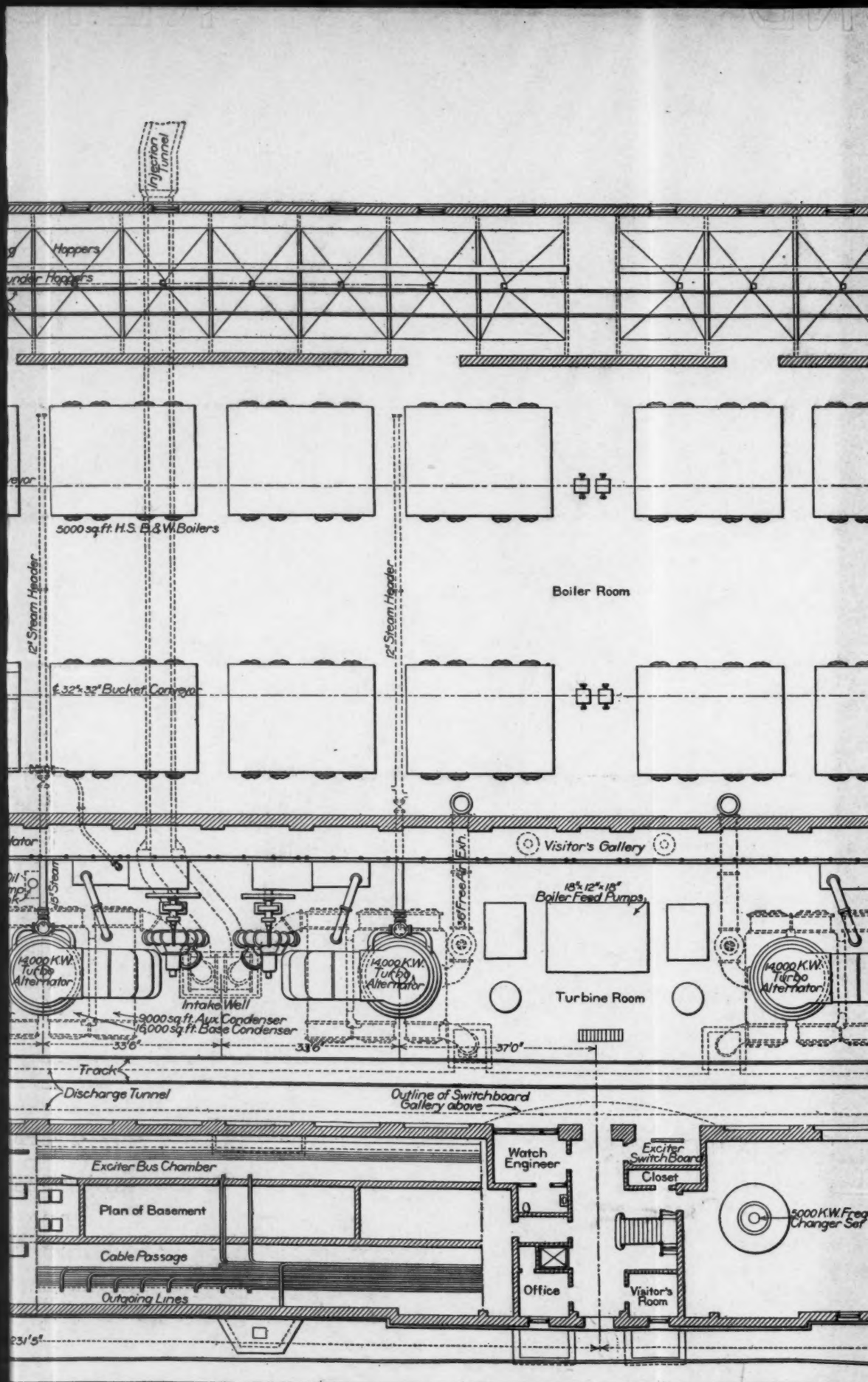
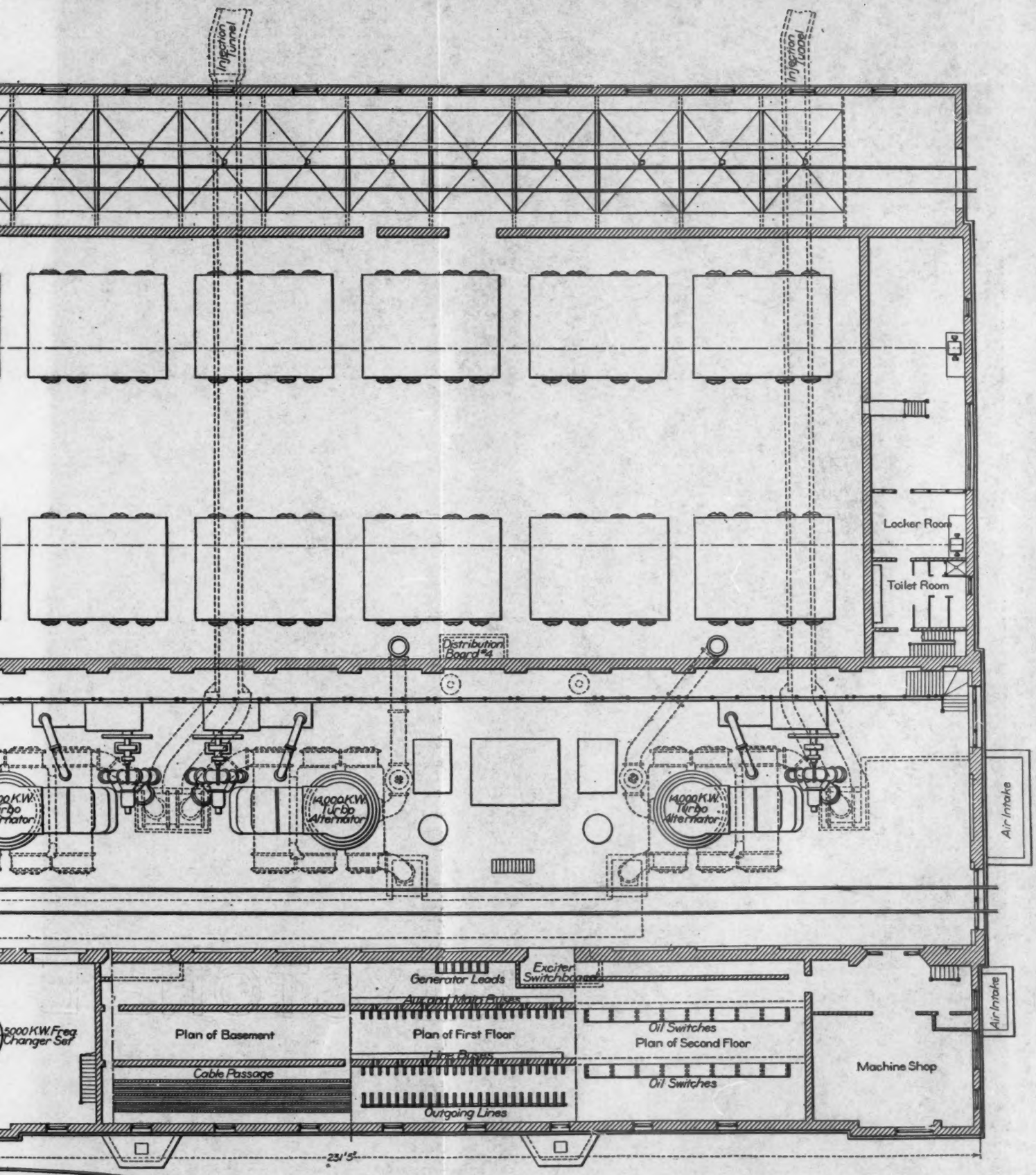


Fig. 8—Plan View Showing General Arrangement of the Quarry Street Station.


Injector
Injector
Locker Room
Toilet Room
Distribution Board #4
14,000 K.W. Turbo Alternator
14,000 K.W. Turbo Alternator
Air Intake
Air Intake
Generator Leads
Exciter Switchboard
Plan of Basement
Plan of First Floor
Plan of Second Floor
Oil Switches
Oil Switches
Cable Passage
Outgoing Lines
Machine Shop
23'3"

t Station.

ment next the turbine-room wall is a passageway containing the cables for the excitation system and for light and power for the station. Between the two is a space occupied principally by two excitation storage batteries. Here also are the motor-driven ventilating fans, which heat and ventilate the switch house.

The western end of the basement forms the basement of the substation and contains the copper for the rotary-converter connections. The direct-current feeder cables start here, and the blower for the transformers is also placed in this basement. Here also is one of the air intakes connected with the ventilating ducts for the turbo-generators, as already mentioned. At the east end of the switch-house basement are located toilet-rooms, lockers, lavatories and shower baths for the turbine-room force.

The first floor of the switch house is on the level of the turbine-room floor. On this floor are located the high-tension bus compartments (Fig. 10), buses and the potential and current transformers connected to them. Here also are the terminal boards to which the secondaries of these transformers are connected. The potential transformers are rated at 200 watts each and are connected to the buses through the new S. & C. high-potential fuses designed to break in a special liquid.

Five alcoves project from the turbine room into the first floor of the switch house. These contain marble switchboards, two controlling the light and power distribution for the station building itself and three for excitation. There are also two light and power distribution boards in the north wall of the turbine room, so that in all there are four distribution switchboards and three excitation boards placed at intervals around the turbine room. The two distribution boards in the north wall of the turbine room control the local distribution of light and power in the boiler room. A view of one of the excitation switchboards in its alcove is shown in Fig. 11.

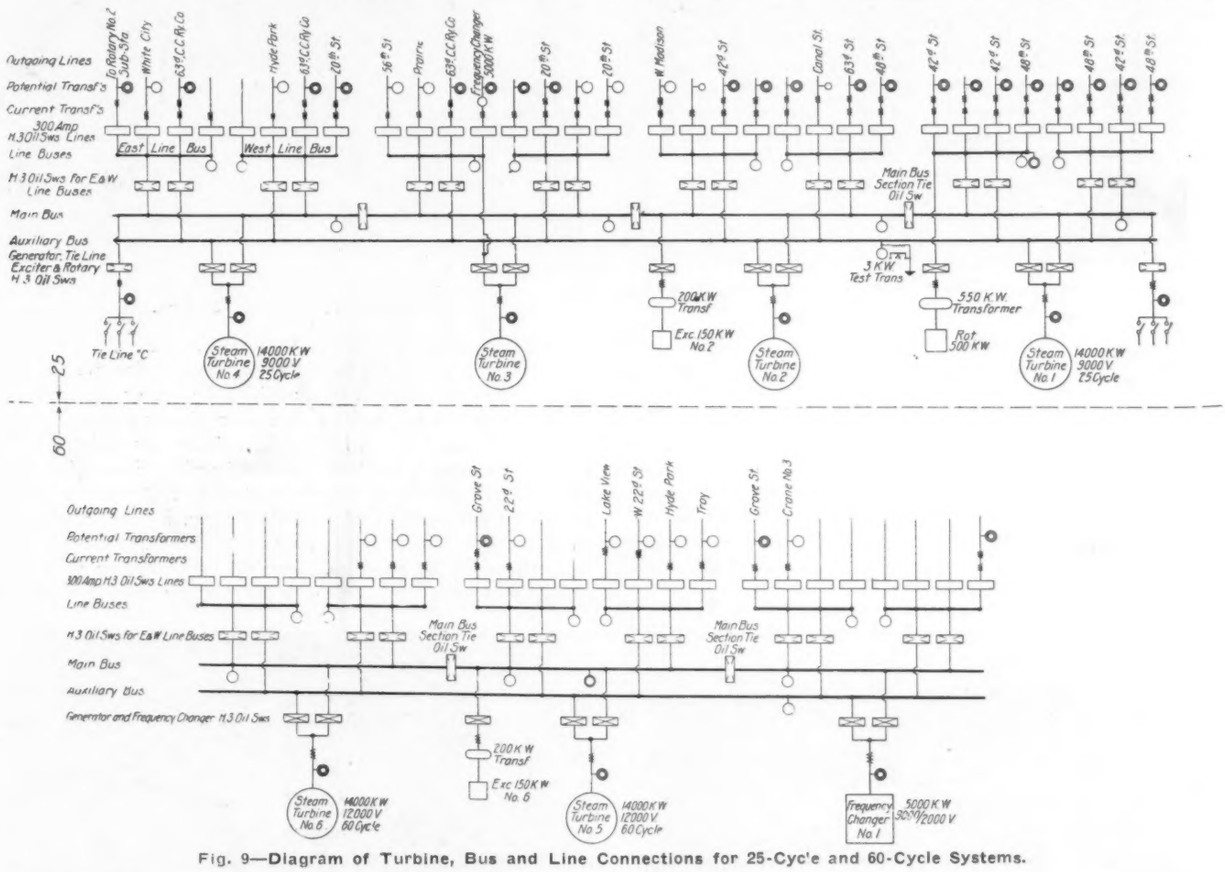


Fig. 9—Diagram of Turbine, Bus and Line Connections for 25-Cycle and 60-Cycle Systems.

SUBSTATION.

The western end of the first floor of the switch house, as indicated in the general plan (Fig. 7), is devoted to the substation, which supplies the electrical energy for local consumption about the premises. The equipment includes two 500-kw rotary-converter outfits, one of these being a split-pole rotary and one a standard rotary with induction regulator. There is a seven-panel white marble switchboard in this substation. This board contains the controlling equipment for the two rotary converters, and feeders run from it to the four distribution switchboards which have been mentioned. No feeders from this substation are taken out of the building. However, there are three 220-volt, direct-current tie lines between this board and the West Twenty-second Street substation (the Fisk Street substation), with connections into Fisk Street. There are also lines connecting the tie lines just mentioned to Fisk Street station direct. As a further reserve there is a large storage battery in the West Twenty-second Street substation. Some details of the load carried by the Quarry Street local substation are given farther on in this article under the heading "Station Light and Power."

FREQUENCY CHANGER.

One interesting feature of the Quarry Street station is the 5000-kw frequency changers, which is of the vertical type. This machine is placed on the first floor of the switch house in a room opening into the turbine room. A picture of it is given in Fig. 13. The frequency changer is provided with a ventilating duct very similar to those used on the turbo-generators, and at the top is mounted the 125-kw exciter. The exciter is also used in starting the machine. The controlling panel for this frequency changer is shown at the right in the picture. A 30-ton hand-operated crane with electric hoist spans the room in which the frequency changer is placed.

The central pavilion of the switch house, on the first floor, also contains the watch engineer's office and other offices and rooms for visitors. The main entrance to the station, shown in Fig. 4, leads to this central pavilion.

At the eastern end of the first floor of the switch house, as shown in Fig. 7, is the machine shop for the station. Here

there are lathes, drills, presses and various machine tools, all driven by direct-current motors.

OIL SWITCHES AND KINDRED APPARATUS.

On the second floor of the switch house are all of the high-tension oil switches, 112 in number. These are of the type known as H3, and Fig. 12 is a view of this floor of the switch house, looking east, showing a number of them. The oil

Fig. 10—Bus Compartments Situated on First Floor of Switch House.

switches shown in this picture are for the 12,000-volt, 60-cycle section. The line switches are shown at the right, and the generator and group switches at the left. The oil switches are of two sizes, rated at 300 amp and 1200 amp respectively. Each generating unit has eight 300-amp switches and eight 1200-amp switches. As shown in the picture, the switches are placed in two rows, the south row for the line switches and the north row for the generator switches and bus ties. The south row contains 300-amp switches and the north row those of the 1200-amp type. End switches on the north group for each unit are used for the tie lines and exciters.

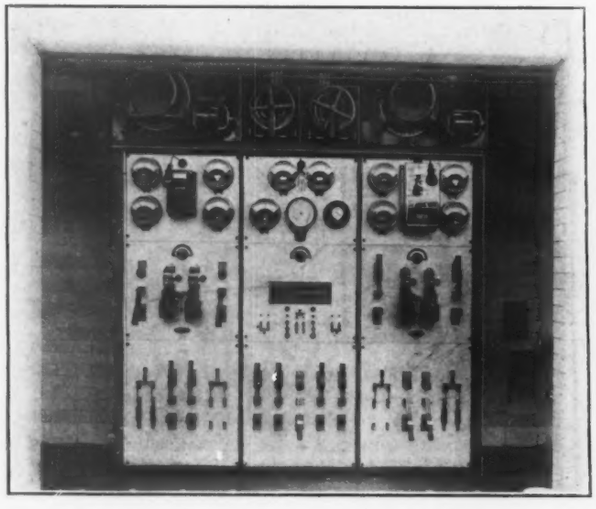


Fig. 11—Excitation Switchboard in Alcove.

At the bottom of the oil switches are located disconnecting switches of the lock-bolt type shown in Fig. 14. The lock bolt has been developed to meet the need for a disconnective which, when open, cannot fall shut, and when closed is locked firmly in that position to prevent blowing out in case of a heavy "short." By a special arrangement the operating rod cannot be released or inserted except when the switch is fully opened or fully closed—that is, when the lock is performing its function. The disconnecting switch permits the oil switch to be disconnected from the bus for repairs or for "killing" lines or buses through an air-gap.

The doors of the oil-switch compartments are made of wood and glass. Doors are provided on each of the two outward-facing sides of the compartments. The upper doors—that is, the doors leading to the oil-pot compartments—are suspended from hinges at the top, and are alternately fastened and left free to swing. The object of this arrangement is to prevent the gas from any explosion in an oil-switch compartment from affecting the adjoining compartments on that side. At the top of these hanging doors are small "cuckoo-clock" doors with helical hinges, which serve as an additional vent, or safety valve, for relieving the pressure in case of a violent opening, as by heavy short-circuits. All oil-switch doors are painted light gray, resulting in a brighter room and making it a safer place to work in. A strip of the compartments 1 ft. wide and just above the floor is painted very dark gray, so that it will not show stains resulting from cleaning the floors.

Fig. 12—View of Switch House, Second Floor, Showing Oil Switches in 60-Cycle Section.

North of the oil switches, along the turbine-room wall, is a passageway containing conduits leading to the operating gallery and containing instrument and control cables. Here also are terminal boards, to which the control wires of the oil switches are connected.

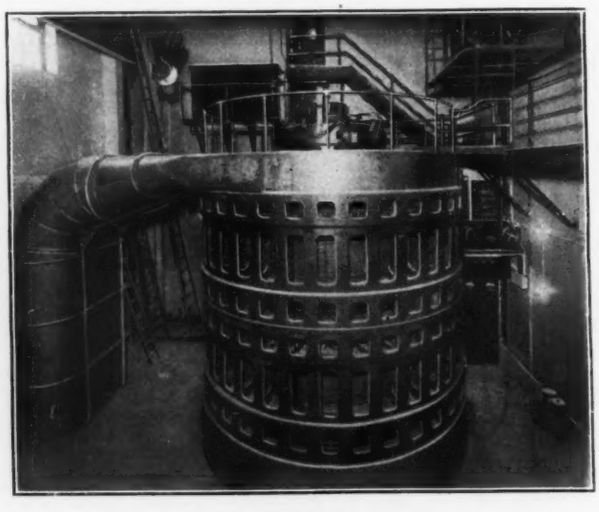


Fig. 13—Frequency Changer.

On the south side of this floor of the switch house are signal boards, grounding devices, high-tension test cabinets and also various accouterments, such as rubber gloves, etc., used for the safety of attendants in pulling disconnecting switches and making break-down tests. A signal board is provided for each unit.

On it are mounted lamp signals indicating what lines are in service. There are also provided intercommunicating signals connected to the operating gallery to inform the operator in the gallery whether the lock on the control of the oil switch has been set or whether the disconnecting switches have been opened or closed. The test cabinets are interconnected and are used for plugging-in leads to connect to lines or buses for break-down tests.

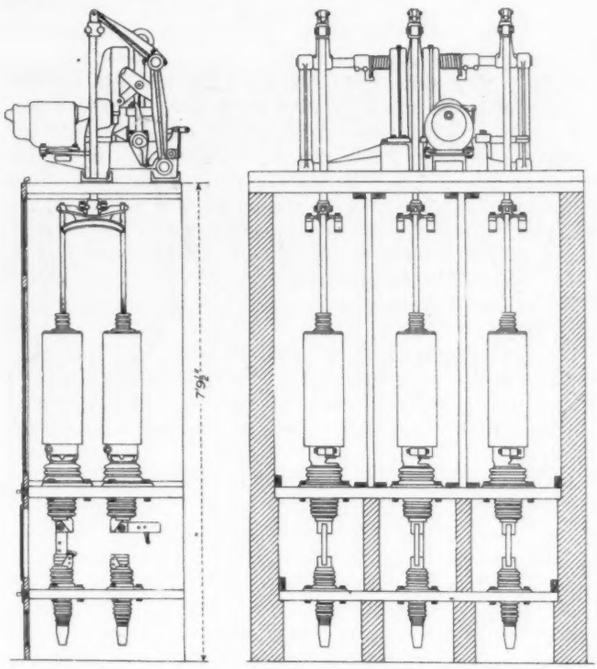


Fig. 14—Diagram of Oil-Switch Compartment, Showing Arrangement of Lock-Bolt Disconnecting Switch.

At the east end of this second floor is located a storeroom in which are kept spare parts, armature coils, etc., in great number and variety. In the corresponding room at the west end of this floor, above the substation, is the electrical repair shop. Motor-operated exhaust blowers are also placed in this room.

OPERATING SWITCHBOARD AND GALLERY

As has been stated, the central pavilion of the switch house is higher than the flanking wings. It provides for a third floor in the switch house, and on this third floor is the operating gallery from which the station is controlled and operated. Here also is the chief electrician's office, a room for testing and a sleeping room. The gallery is arranged with a curved glass front projecting into the turbine room, so that an unobstructed view of all the generating units may be obtained from it. In the general view of the turbine room, shown in Fig. 1, the projecting front of the operating gallery can be seen at the right.

Fig. 15 is a plan of the operating gallery. The general arrangement consists of the use of benchboard generator panels on the north side of the gallery, or the side having the glass front projecting into the turbine room, and line-control panels on the south side of the gallery. Both the generator panels and the line-control panels are divided into two sections, and the eastern end of the gallery is devoted to the switchboards for the 12,000-volt, 60-cycle generators and line control, the 9000-volt, 25-cycle generator and line panels being at the western end. The switchboards are arranged in the curving position shown, and in the center of the gallery (from which position by this arrangement all the instruments on the various boards may be seen) is placed the operator's desk. This desk is shown in the photograph (Fig. 16), which is a view of one-half of the operating gallery, looking west, and showing on the right the 9000-volt, 25-cycle generator panels and on the left the line-control panels for the same voltage and frequency.

The arrangement for the eastern half of the gallery is symmetrical with the western half, as indicated in the plan, Fig. 15. The western half of the gallery, shown in Fig. 16, contains the generator benchboards for units Nos. 1, 2 and 3 and an exciter and battery benchboard. It also contains line-control boards for units Nos. 1, 2 and 3 and a control board for the Fisk Street tie lines. The eastern half of the gallery contains, on the north side, generator boards for units Nos. 4, 5 and 6, and also a combined frequency-changer and exciter benchboard. On the south side of this half of the gallery the line-control boards are for units Nos. 4, 5 and 6, and there is also a line-control board for the frequency changer. The operating gallery is provided with a false floor of marble, and under this are placed all conduit lines leading to the switchboards. The operating gallery is lighted by a large skylight.

In addition to the switchboards mentioned there is a separate frequency-changer board at the eastern end of the gallery, consisting of two panels, one for the frequency changer proper and the other for fire-alarm service and other instruments.

At the central operator's desk are kept the load records, and three telephones are here provided. One telephone communicates directly with the load dispatcher at 139 Adams Street, one is an intercommunicating local instrument and one is connected to the Commonwealth Edison branch telephone exchange.

The switchboard panels are all of black Monson slate, framed

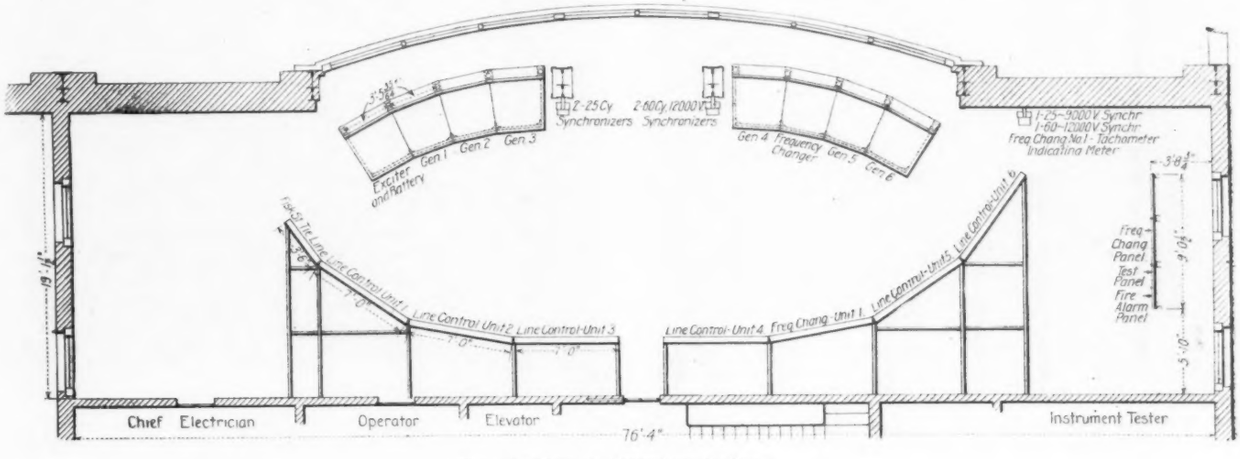


Fig. 15—Plan of Operating Gallery.

in gilded iron molding. As stated, the generator-control panels are of the benchboard type with the instruments placed on the upper vertical portion and the control, the control signals and the miniature bus on the horizontal or bench portion of the board. The apron of the bench, or the vertical part below it, carries the voltmeter switches and the main operating bus

switches. A space is left between the upper vertical portion and the bench portion of the generator switchboards to enable the operator to look between them into the turbine room through the projecting glass front of the operating gallery.

Fig. 17 is a nearer view of four of the line-control panels. The panels shown in the illustration are for the 25-cycle system, but the 60-cycle panels are not materially different in construction. Referring to Fig. 17, the arrangement of instruments is as follows: Indicating instruments are placed at the top. Next come the relays. Below them is a line of control switches, operating the oil switches, and at the bottom are the watt-hour meters. All instruments are placed in a vertical line, and there are four of these lines to a panel and eight to a unit.

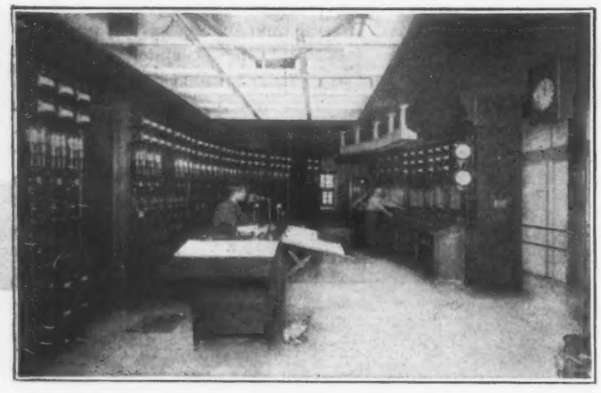


Fig. 16—View in Operating Gallery Looking West, Showing 25-Cycle Generator and Line Switchboards.

A rear view of some of the line panels is given in Fig. 18. Owing to the possible short-circuiting of terminals back of the switchboard by the dropping of tools used by meter testers and by such other troubles as are liable to be caused in working on line circuits, a connecting device has been applied to each instrument to avoid the necessity of removing instruments. This is styled a test-adapter and is used for cutting any defective instrument out of circuit and also for connecting an instrument or relay to a bus for testing. The buses are connected to terminals placed in front of the switchboard and also leading to a special panel on which is mounted a test meter.

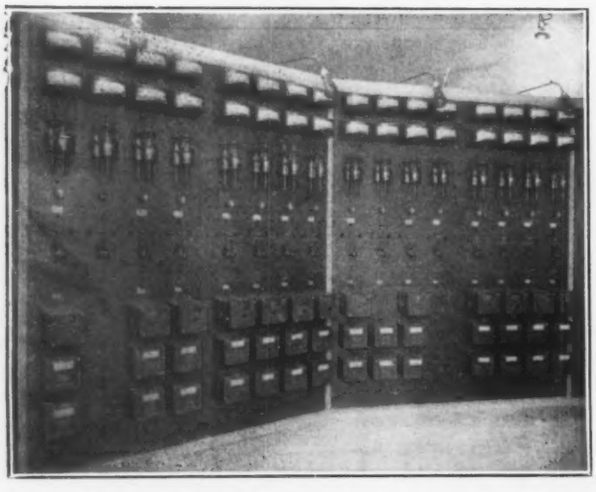


Fig. 17—View in Operating Gallery, Showing Line-Control Panels (Nearer View to Show Details).

EXCITATION.

There are two 150-kw, 125-volt motor-driven exciters and three 150-kw exciters driven by steam turbines. A motor-driven exciter is placed at each end of the turbine room and the steam-driven machines are located along the north wall of the turbine room. All of these exciters are interconnected between the excitation switchboards, making one excitation system, which, however, can be sectionalized. In addition there are two excitation batteries, each consisting of seventy cells provided with Exide plates. Fig. 19 shows the connections of the excitation system.

As previously remarked, there are three excitation switchboards of three panels each placed in alcoves off the turbine room. These are of white Italian marble, with ornamental iron frames. Fig. 11 shows one of these boards. The boards contain the various throw-over switches, generator-field switches and the indicating and integrating instruments for all exciters and batteries. The two outside panels carry the solenoid-operated switches and the meters for the field leads for the turbo-generators. There is thus one of these panels for each turbo-generator. Mounted on these outside panels, also, are the main switches for the exciters, connected to buses located on the back of the board. These buses are interconnected by cable. The middle panel in each board supports the instruments, end-cell indicators and main switches for the excitation batteries.

Above the excitation switchboards are placed the generator-field rheostats and the exciter-field rheostats. The former are motor-operated and the latter are controlled by ratchet-head switches. In front of these boards is a rolling shutter, electrically tripped, to serve in case of need as a fire curtain for protection. These shutters are controlled by gang switches placed at both ends of the turbine room.

NEUTRAL LEADS.

Along the south wall of the basement of the turbine room are placed the oil switches connecting the neutral leads of the 25-cycle and 60-cycle generators to the neutral bus. This bus is connected to the main ground bus by two neutral resistances of 2.5 ohms each. These two resistances consist of iron grids, and there is one at each end of the basement. Normally, the 60-cycle neutral bus is separate from the 25-cycle bus, but they can be connected together in the event of failure of either neutral resistance.

STATION LIGHT AND POWER.

The substation, which has been briefly described, supplies electrical energy for 107 arc lamps, 2900 incandescent lamps and forty-three motors having a total rating of 712 hp. It will be seen, therefore, that the load for the building itself is of no mean proportions. The feeders connecting the substation switchboard to the four distribution boards are 1,000,000-circ. mil. cables, and there are two 250-volt direct-current feeders leading to each board. One is enough to carry the load, the

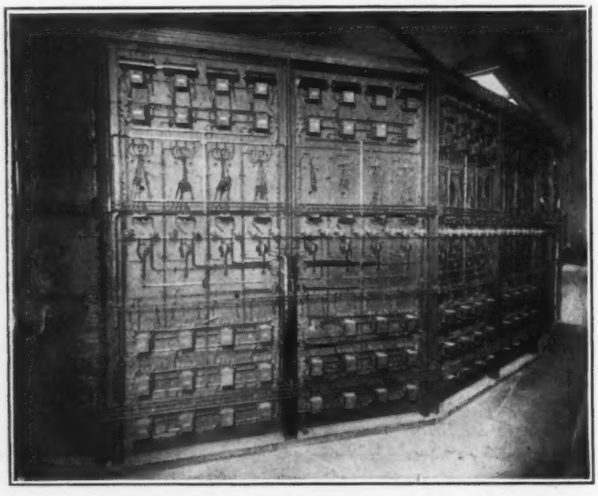


Fig. 18—View in Operating Gallery, Showing Rear View of Line-Control Panels.

other being a reserve. On the distribution boards are placed the switches for the various motors and cut-out boxes. All motors are of the direct-current, 220-volt type and range in rating from 2 hp to 150 hp. They operate cranes, bilge pumps, ventilating fans, conveyors, coal crushers, coal unloaders, stokers, air compressor, fire pump, etc.

The cut-out cabinets control from twelve to twenty circuits each for arc and incandescent lighting. The general illumination of the turbine room and boiler room is by arc lamps. The yard lighting is also by arc lamps mounted on posts. The lighting of the remainder of the bulding and detail lighting is by incandescent lamps. Certain important incandescent lighting circuits are carried normally on the storage battery, and other lighting circuits are arranged to be thrown over by an emergency switch from the normal source of supply to the storage battery. Thus no emergency can arise when the station will remain in total darkness.

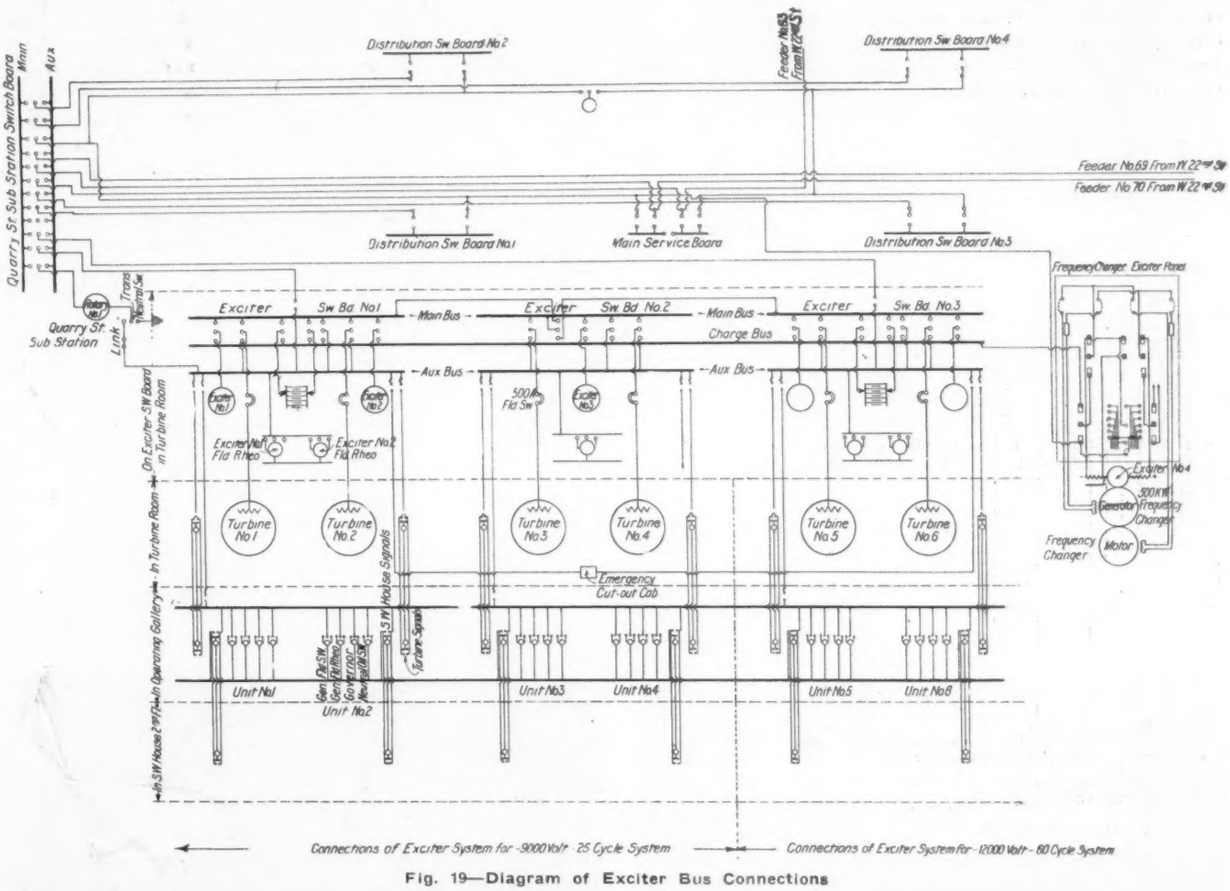


Fig. 19—Diagram of Exciter Bus Connections

The cut-out cabinets control from twelve to twenty circuits each for arc and incandescent lighting. The general illumination of the turbine room and boiler room is by arc lamps. The yard lighting is also by arc lamps mounted on posts. The lighting of the remainder of the bulding and detail lighting is by incandescent lamps. Certain important incandescent lighting circuits are carried normally on the storage battery, and other lighting circuits are arranged to be thrown over by an emergency switch from the normal source of supply to the storage battery. Thus no emergency can arise when the station will remain in total darkness.

SAFETY AND FIRE PROTECTION.

Great precautions have been taken to insure the safety of the operating force, both in the steam and the electrical parts of the station. All the latest appliances available to this end have been installed, and there are devices of all sorts to insure the health, safety and comfort of employees. In the train shed and boiler room, at various convenient locations, are placed red lights indicating the location of push switches which in an emergency may be used for tripping the switches controlling the motors operating the conveyors. Thus, in case of accident, as of a man being caught in a coal conveyor, for instance, the mechanism can be stoped at once from any one of a number of easily accessible points.

Similarly the arrangements for fire protection are very complete, although the building and its contents would seem to be themselves practically fireproof. A special fire pump in the boiler-room basement is connected to a 150-hp motor and is arranged to be supplied with electricity by either of two 1,000,000-circ. mil feeders. This pump, which is of the centrifugal type, can deliver 1000 gal. of water a minute at 150-lb. pressure to a permanent piping system with plugs placed at convenient points about the building and property. An ample supply of hose on reels is accessible for the well-drilled fire brigade made up of station employees. The piping system has a further connection at the river by which a fireboat could force water through it. In addition, there is a similar connection on the street, to which fire engines could be attached. Fire-alarm boxes are placed in and about the building. The "pulling" of one of these boxes signals the operators on duty in the operating gallery and also makes a record at that place. The switchboard operator then, by remote control, causes a whistle to be blown in the boiler room, indicating the number of the box and the station fire department responds.

SECTIONAL OPERATION.

The entire 25-cycle system of both Fisk and Quarry Street stations is sectionalized in such a way that it may be operated in one, two or three sections. The maximum load on any one section is limited to 60,000 kw. At night, at this time of the year, from shortly before midnight to about 6 a. m., the three sections are operated in parallel or as one section. At the hour last named the load is split into two sections as it nears the 60,000-kw limit, and about an hour later it is divided into three sections. The system is operated as three sections until about 9 p. m., then as two sections until a little before midnight, when the two are combined into one as before.

No one portion of the city is exclusively supplied from any one section of the system. On the contrary, care is taken to prevent any given territorial area from being altogether dependent on any one of the three sections. This is a provision for safety in case of break-down and, furthermore, tie lines between the various substations are provided for emergency use.

When the 25-cycle system is operated in two or more sections, the four 25-cycle generating units at Quarry Street are at present connected two to one section and two to another, with tie lines connecting with corresponding sections at Fisk Street. Fisk and Quarry Street stations are so operated together that the load on the tie lines is a minimum. The switches on these tie lines are provided with overload relays so that a disturbance in either station will have little effect on the load of the other station.

Sixty-cycle units are operated in one system. There are only two of these units, both located at Quarry Street, and they have a combined rating of 28,000 kw, while at Fisk and Quarry Street together there are fourteen 25-cycle units, aggregating 176,000 kw. The 60-cycle energy is transmitted to Edison substations and transformed down to 2300-4000 volts for distribution circuits. The 12,000-4000-volt transformers by which this is accomplished were first installed in 1909 and are now carrying the long-hour load, with the substation frequency changers (9000 volts and 25 cycles to 4000 volts and 60 cycles) helping out on the peaks where needed. As the 60-cycle system expands the 12,000-volt transformers in substations will ultimately replace the frequency changers, some of which will then be used as synchronous compensators connected to the 2300-4000-volt bus to improve the power factor. Others, of the larger sizes, will probably remain to serve as links between the 25-cycle and 60-cycle systems.

The 9000-volt, 25-cycle outgoing lines from both Fisk Street and Quarry Street supply (besides the frequency changers, as mentioned above) the rotary converters in the Edison and railway substations and also three 5000-kw step-up transformers at Fisk Street for 20,000-volt transmission lines. Fig. 20 is a drawing showing the component parts of the system. This drawing is an amplification of one of similar nature prepared for a paper read by Mr. R. F. Schuchardt, electrical engineer of the Commonwealth Edison Company, before the Chicago Section of the American Institute of Electrical Engineers on June 5, 1908, and entitled "Recent Developments in Protective Features of a Large High-Tension System." It is interesting to note that while the original drawing was prepared only two and a half years ago, it indicated the 84,000-kw Quarry Street station, now completed and described in the present article, as "under construction," whereas the diagram presented herewith shows the Northwest 120,000-kw station as "under construction," so rapidly does the business of the company expand.

The general plan of operating the Fisk and Quarry Street stations is practically the same as that outlined in the *Electrical World* of May 27, 1909, in an article entitled "Practical Operation of Fisk Street and Quarry Street Stations in Chicago." Since that time, however, Quarry Street station has been placed in full operation, and both stations are now operated twenty-four hours a day.

ENGINEERS, ARCHITECTS AND CONTRACTORS.

Following is a list of the names of the engineers, architects and principal contractors for the Quarry Street station: Consulting mechanical engineers, Sargent & Lundy; electrical engineers, engineering department of Commonwealth Edison Company; architects, Shepley, Rutan & Coolidge; general contractors, Wells Brothers Company; boilers and stokers, Babcock & Wilcox Company; turbo-generators, exciters, high-tension switching equipment and control, General Electric Company; condensing equipment, Henry R. Worthington; boiler-feed pumps, Dean Brothers and Henry R. Worthington; overhead traveling cranes, Whiting Foundry & Equipment Company; coal and ash handling machinery, Mead-Morrison Manufacturing Company; boiler setting and lining of ash pits, H. A. Bishop; excitation batteries, Electric Storage Battery Company.

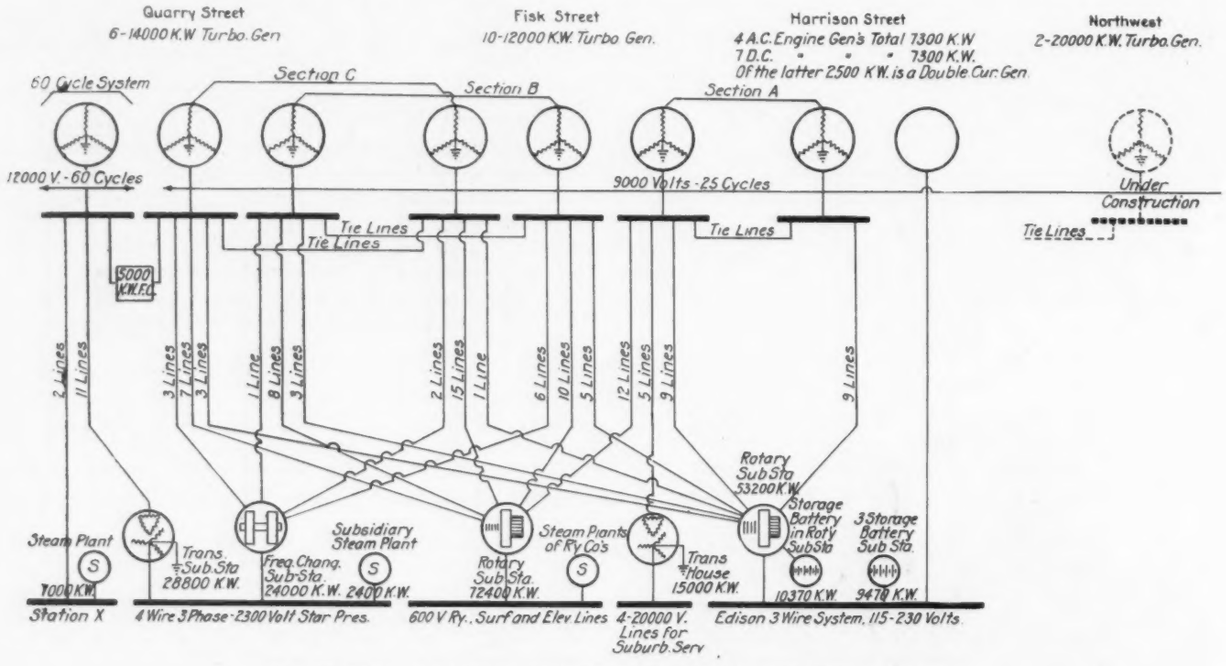


Fig. 20—Diagram of Component Parts of Commonwealth Edison System.

OVERLOAD BOILER OPERATION AT ST. LOUIS.

A series of tests recently made on the twelve new water-tube boilers in the Ashley Street station of the Union Electric Light & Power Company, St. Louis, have shown that these 508-hp units can be operated at an output of 250 per cent of their normal rating. For several years it has been the practice of the St. Louis company, as it is now in several other places, to operate all boilers in service normally above their full rating, forcing them in times of peak load to the maximum output of the heat units in the coal that can be burned in the furnaces. The Union Electric Company has recently contracted for two new 4000-kw, horizontal, 60-cycle Curtis turbine-alternator units which will be installed in the Ashley Street station in March and June, 1911. By July, 1911, the last of the 5000-kw turbine units with which this station was originally equipped will have been replaced by a 12,000-kw turbine alternator.

UNDERGROUND INSTALLATION AT MIDDLETOWN, OHIO.

MIDDLETOWN is in Southwest Ohio. It is an enterprising manufacturing town with flourishing steel, paper and tobacco industries. It is well located for manufacturing purposes, having three railroad lines to facilitate shipping. The population of this place is 13,400; when the new plant of the steel-rolling mill, now nearing completion, is put in operation the population is expected to increase by at least 1000.

A franchise was recently granted to the Middletown Gas & Electric Light Company to furnish electricity for light, heat and industrial purposes, provided that the company placed all its wires underground. It may be well to mention that there has been and is a competing electric light company in operation, using overhead distribution.

The Middletown Gas & Electric Light Company after a thorough canvass obtained many prospective consumers, largely on the merits and advantages of underground distribution, enough to represent a fair return for the capital invested. It was not necessary to offer lower rates to obtain consumers.

The station was located near the company's abandoned coal-gas plant. This plant was abandoned when natural gas was brought into the town, but the plant is kept in reserve so that it can be started on short notice in case the natural-gas supply should fail. The electric power house was located here because gas engines are used as prime movers, and two large containers are kept filled with gas, which would run the gas engines for several days in case of accident cutting off the natural-gas supply.

The power station is a brick building having a slate roof, in which are placed sky-windows and vents; there are also a number of large windows, which furnish a flood of daylight and give the station-room a bright appearance.

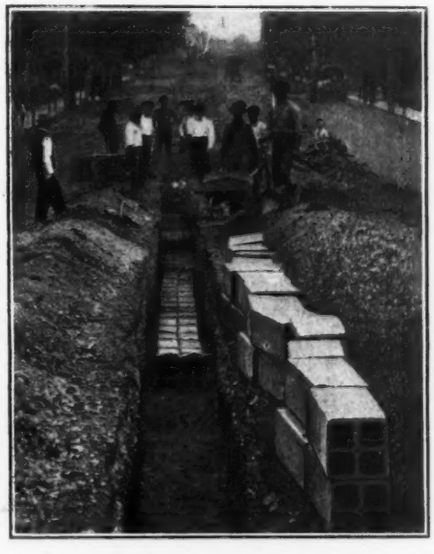


Fig. 1—Laying Out Clay Ducts.

At present only two units are installed; room is being provided for future growth. The units are 350-kw and 150-kw, three-phase, revolving-field alternators designed for 2300 volts, 60-cycle, directly connected by flexible couplings to a 400-hp and a 200-hp, four-cylinder and two-cylinder horizontal natural gas engine. The engines are started with compressed air, which is furnished by a 6-hp gas engine and pump; exhaust chambers, 4 ft. x 6 ft. x 5 ft., placed underground and built of concrete receive the exhaust from the engines; only two cylinders exhaust into one chamber; each chamber is provided with an outlet of an 8-in. pipe leading straight through the roof of the building. Water for the jackets of the gas engines is taken from the city mains. The switchboard consists of two feeder panels and two generator panels. The switchboard is of standard type and on its face are mounted the usual instruments. It offers nothing of special interest.

A most important problem in connection with this plant was to lay out properly the distribution network. A careful study was made of the town and the main ducts were located in

Fig. 2—Laying Out Fiber Ducts.

streets and alleys where business appeared most promising. The shortest possible routes were selected to a number of large consumers with whom contracts have been entered into. These consumers demand a day load of approximately the output of the large generator.

The underground conduit and cable system was laid out with a view to accommodating a city of 40,000 people. While this is not necessary at present, it was thought best after thorough consideration to adopt this far-sighted policy. On the main street twelve ducts were laid. Nearly all the other lines were six ducts and were mostly laid in alleys. At street intersections are manholes from which fiber laterals are run to transformer poles located in the backyards which adjoin the alleys, from which poles many houses can be reached with secondary overhead wires. By adopting this method of distribution the underground-cable system was confined to the use of primary cables, which greatly reduced the cost of the system.

The ducts are embedded on all sides with a 3-in. layer of concrete. The manholes were built of brick, 5 ft. x 5 ft. x 5 ft. At present about 60,000 duct-feet of multiple clay and about 2000 duct-feet of fiber duct are installed. About 18,000 ft. of No. 2 and 8000 ft. of No. 6 three-conductor, 2300-volt, paper-insulated lead cables are laid and also about 1000 ft. of No. 6 rubber-insulated lead cable for laterals. The rubber cable was used in terminating cables on poles, thus dispensing with the use of terminal heads. The end of the lead was served back, thoroughly taped, received a coat of P. & B. paint and was connected directly to the transformer cut-outs.

The gas engines were furnished and set up by the Bessemer Gas Engine Company. The generators and switchboard were furnished and installed by the General Electric Company. The distribution system was designed by the Safety Insulated Wire & Cable Company, which also had the contract for installing the conduits and furnishing all the cables required.

EXHAUST-STEAM TURBINE PLANT AT VIRGINIA, MINN.

An example of the benefit of the low-pressure steam turbine in a case where it was desired to increase the efficiency of a plant operated on steam pressures varying from 145 lb. to 80 lb. per square inch is afforded by the unique engine and turbine installation of the Virginia (Minn.) Electric Power & Water Company, which obtains its steam from a lumber-mill boiler plant 1500 ft. distant from the generating units.

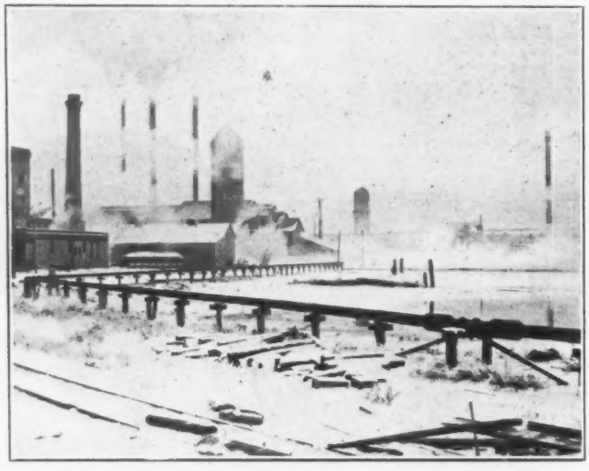


Fig. 1—Eight-Inch Steam-Pipe Line, 1500 Feet Long, from Lumber Mills in Background to Virginia Electric Company Plant.

The City of Virginia, with its population of 12,000, is in the center of the important Mesaba Range lumbering and iron-mining region, and the sawmill of the Virginia & Rainy Lake Lumber Company there is one of the largest plants in the Northwest. The great quantity of wood refuse from the "hogging" machines has always been in excess of the needs of the lumber company for its own boilers and power purposes, and this waste material is burned in huge screened cupolas or used as filling to reclaim parts of the plant property. The boiler house of the lumber mill is 1500 ft. distant from the electric company's generating station, but about three years ago an agreement was entered into by which the latter obtained steam for operating its engine-driven alternators and steam pumps through an 8-in. pipe line from the lumber plant's boilers.

The construction of this 1500-ft. pipe line, which has now been successfully operated for three years with the original engine installation, is shown in the accompanying illustration, Fig. 1. The 8-in. pipe is covered with a 2-in. coating of magnesia insulation, inclosing which is a covering of 0.25-in. painted canvas. At points where the pipe rests on rollers carried on wooden posts 2-in. saddles are strapped on to protect the canvas covering. At 200-ft. intervals expansion joints are inserted in the pipe line to allow for temperature changes. One of these is shown in the foreground of the picture. The entire pipe line is given a grade toward the electric company's plant of 2.5 in. for each 100 ft., and ends in a receiver tank from which a Crane automatic trap withdraws whatever condensation occurs. Even in the sustained severe winter temperature of from zero to —10 deg. Fahr. encountered in northern Minnesota, this trap draining the 1500 ft. of 8-in. line discharges less than 10 gal. of condensation water an hour, and the snow is said to lie on the canvas covering unmelted during cold winter weather.

Following the rapid growth of the population of Virginia about a year ago and the consequent increase in the electric lighting demand it was decided to increase the output of the station and to utilize more efficiently than in the simple, non-condensing engines the steam consumed by the plant. The steam pressure supplied from the lumber-mill boiler plant varies widely with the demands of its own engines, sometimes ranging from 80 lb. to 145 lb. per square inch at the head of the pipe line, so that the conditions seemed unfavorable for a high-pressure turbine installation at the electric company's plant 1500 ft. distant. It was accordingly decided to employ a high-pressure reciprocating engine as before, which would be less affected by the variations in steam pressure, allowing this to exhaust into a low-pressure steam turbine which could also utilize the exhaust of the water-pumping, air-compressor and fire-service pumping units in the station. During periods of light pumping load when the engine-driven units are shut down the turbine is arranged to take live steam as needed through a reducing valve.

The 350-kw low-pressure turbine-generator set installed is of the 2300-volt, 60-cycle Allis-Chalmers type, like the 300-kw engine-driven unit in parallel with which it operates during the peak-load period. In addition to these the plant equipment includes an auxiliary belted 200-kw General Electric alternator driven by one of the original G. H. Corliss engines built forty years ago. The steam-pump equipment for the water-works and fire service comprises a 30-hp compound air compressor for operating an air-lift well delivering 500 gal. per minute into a 275,000-gal. ground-level cistern, from which a 10-hp reciprocating pump raises it 80 ft. to a 100,000-gal. overhead tank. Two Underwriters' fire-protection pumps are also installed, but since these are operated only in case of emergency their exhaust steam does not become continuously useful for turbine operation. The arrangement of these various units is best shown by the accompanying sketch, in which the steam headers are shown by solid lines and the exhaust pipes by dotted lines. From the entry receiver and trap the steam is brought into an overhead header through a reducing pressure valve, branch headers supplying steam to the various pumping units, condenser circulating engine and main reciprocating engines. The exhaust from all the steam pumps is collected in a low-pressure line which is connected at one end to a steam-heating system serving the company's offices and nearby dwellings, and is closed at the other end by a relief-valve set to open at 1 lb. pressure above atmosphere. This exhaust header

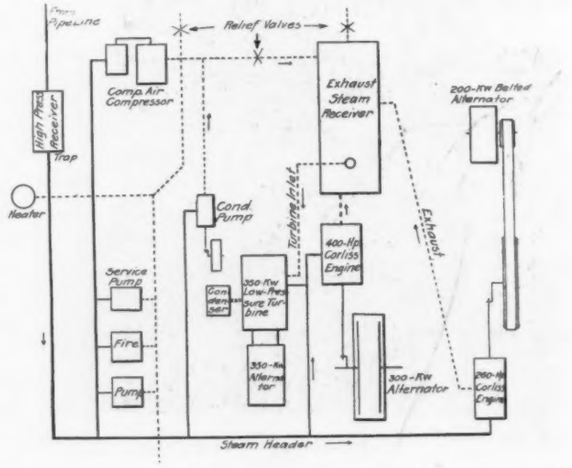


Fig. 2—Arrangement of Station Apparatus—Steam Lines Solid, Exhaust Lines Dotted.

is also connected to the intermediate receiver, between the turbine and reciprocating engines, through an equalizing valve set at 0.5 lb. above atmosphere. The receiver, into which the two engines exhaust, is also connected to the atmosphere through a relief valve set to open at 1 lb. pressure. From the receiver the low-pressure steam passes through an oil separator and directly into the exhaust turbine. A 2.5-in. live-steam tap is also carried to the automatic valve on the turbine, which opens to admit high-pressure steam when the reciprocating

units are not exhausting enough steam to carry the turbine load.

The turbo-generator is operated continuously during the twenty-four hours, having now been run without shut-down since March, 1909. The nature of the water-pumping load requires that the 30-hp air compressor and the 10-hp duplex pump shall also be run continuously, and these, together with the 10-hp engine driving the turbine condenser pump, supply sufficient exhaust steam to carry ordinary day electrical loads on the turbine. Not until the turbine load begins to exceed

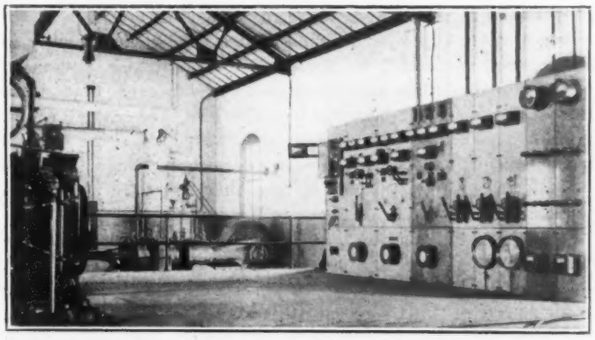


Fig. 3—Switchboard and Compound Air Compressor.

100 kw is the live-steam valve called upon for the admission of steam from the pipe line. If the turbine demand falls below the steam quantity exhausted by the pumping units, the relief valve in the exhaust header opens to the atmosphere. The condenser vacuum is normally maintained very high, approximating 27 in., while during day-load operation a vacuum of 10 in. or 12 in. is held on the receiver. From the exhaust pipe a heating system is tapped off, aggregating 15,000 sq. ft. of radiating surface in the office of the Virginia Electric Power & Water Company and in nearby dwellings, all within 400 ft. The condensate from this system is returned to a small vacuum pump in the basement of the power plant. The differential setting of the relief valves in the reciprocating-unit exhaust pipes insures that steam will always be available for the heating-system line. The engine-driven unit is ordinarily operated from 4:30 p. m. to 11:30 p. m., during the heaviest lighting load on the station, being paralleled with the turbine-driven

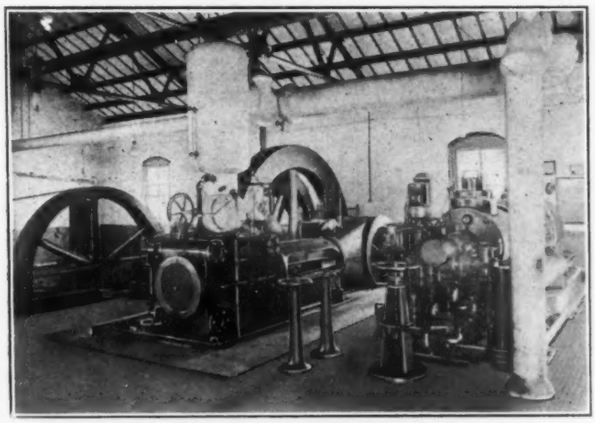


Fig. 4—Corliss Engine and Exhaust Steam Turbine.

generator, which is run continuously throughout the twenty-four hours. In case of breakdown the auxiliary 200-kw engine-driven set can be started up, also exhausting into the receiver. The lumber-mill boiler plant from which the station now receives its steam will shortly be remodeled and the electric company has joined the lumber interests in building a steam tie line with another mill boiler house 600 ft. beyond the first, so that high-pressure steam will be carried a total distance of 2100 ft., or nearly half a mile from boilers to generating units. From the power station as exhaust steam it is then again conveyed 400 ft. further in the mains of the heating system.

The Virginia Electric Power & Water Company also has a modern and completely equipped office building unusual in plants serving a population of similar size. It has 600 lighting customers and a connected day load of 125 hp in small motors. Mr. O. H. Griggs is manager of the company and Mr. J. A. Kennedy is superintendent of the plant and designed the installation of the engine and turbine-driven equipment.

ELECTRIC FIRELESS COOKER DEVELOPMENT.

Successful and Epoch-Making Experiments on Central Station Supply.

IN the popularization of central-station service by the Hartford Electric Light Company the management has long sought to develop off-peak business to the fullest possible extent. Special encouragement has been given to consumers to purchase electricity on a twenty-four-hour basis, and in both the lighting and power fields a large connected load has been secured which is spread over many hours of the day, and which consequently enables the company to make the best use of its plant and distribution system, while at the same time the community finds it advantageous to absorb energy on a distinctly large scale. As a result of this policy the company's income for the present year has reached the maximum of $8 per capita, with a tributary population of only about 115,000, and the prospect of a still larger utilization of electricity in the community is most attractive.

The company's work in developing residential lighting service has already been described in these columns (*Electrical World*, Sept. 1, 1910, page 489), and brief reference has been made to the efforts of President A. C. Dunham and his associates to place electric heating on a genuine commercial basis, in order to compete successfully with coal, gas and oil. Some months ago President Dunham began to experiment with the electric fireless cooker principle in the hope of producing an equipment which would compete successfully with existing agencies, and thus furnish a most desirable class of long-hour business for the company's circuits. The success with which these experiments have been crowned justifies the statement that a new epoch in the sale of electricity is close at hand for central stations desirous of extending their long-hour service, for the tests at Hartford show conclusively that with the electric fireless cooker a family of from three to five persons can be provided for with a minimum revenue of 3 cents per kw-hour, corresponding to a continuous consumption of 150 watts at a flat rate of $3 per month. Any consumption at this rate of $3 lasting less than twenty-four hours per day is a corresponding benefit to the central station, which can sell electric energy profitably for twenty-four-hour service on a large scale at even 1.5 cents per unit.

A net cost of current of $3 per month for a family of the above size for electric cooking is a figure of profound significance to the central-station industry. It means that the day of successful competition with coal, oil and gas is here; that the electric kitchen can be placed in families of even very moderate circumstances and maintained at a profit to the central station without increasing the actual cost of fuel for cooking; that the average householder can enjoy all the delights and advantages of electricity in the preparation of his food at little or no increase in expense over the present crude and wasteful apparatus for coal burning; and it means reductions in the cost of living through the use of the less expensive cuts of meat, the elimination of all insurance difficulties, and the saving of an entire room, if desired, in the modern apartment, at a cost of from $5 to $10 per month. Best of all for the central station, this business can be obtained by the long-hour use of its equipment in numerous installations taking from 50 watts to 150 watts each on rates of $2 or $3 per month. The dis-

tribution of this load throughout many hours of the day will mean only a nominal increase in plant capacity even when the community approaches the electric-cooking saturation point. It is unlikely that anything like the full rated capacity of the individual domestic cooking installations will be continuously required for twenty-four-hour service, although that is to be the privilege of the householder; but too much emphasis cannot be laid upon the fact that if the full rating of the equipment should be demanded the company will still receive its

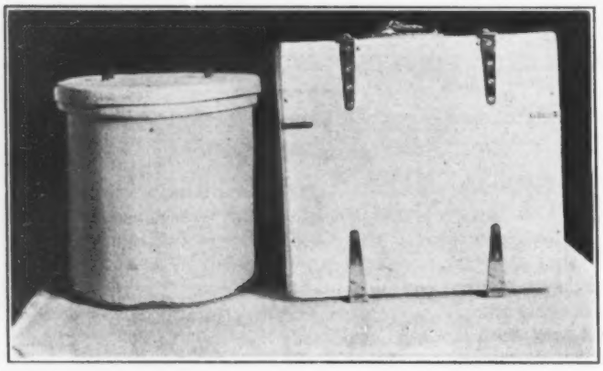


Fig. 1—A 50-Watt and a 100-Watt Fireless Cooker.

minimum income of about 3 cents per kw-hour so long as it maintains the flat rate above mentioned.

In June, 1910, the company began systematic experiments with the fireless cooker under the general direction of Mr. Dunham and the immediate personal supervision of Mr. R. D. Cutler. The initial experiment was the cooking of a pot of Boston baked beans by placing an ordinary 16-cp incandescent lamp inside and insulating the outfit from the external atmosphere. The experiment showed that the beans could be cooked in the best possible manner with a continuous expenditure of about 35 watts, the temperature being maintained at 250 deg. Fahr. with little difficulty. From the beanpot experiment the company extended its work, seeking to obtain the best insulating materials for the cooking device, and at every step careful records were made of the time required to perform a given task and the input in electrical energy which would sustain the required temperatures. The cookers made by the company for its tests have been steadily improved in mechanical features, facilities for cleaning, ease of accessibility, capacity and portability. About a dozen cookers have been built since June, and the company has now reached a point where arrangements are being negotiated for the manufacture of the device on a commercial scale. Early in 1911 the company plans to open an electric cooking school in the apartment equipped with electric devices which has been referred to in these columns, and an electric cookbook will shortly be written and published on the basis of experiments which have been under way during the past half-year. At present the company serves daily to a number of its employees a hearty lunch or dinner prepared entirely on the fireless cooker, and if the personal appearance of the men is any testimonial to the quality of the viands the question of consuming the product of the fireless cooker is permanently settled. A nominal charge of 25 cents per meal is made to cover the cost of food only.

Two sizes of cooker have resulted from the company's experiments, one being rated at 100 watts and the other at 50 watts. The tests have shown that 100 watts input will continuously maintain a temperature of 380 deg. Fahr., which is sufficient for roasting any kind of meat or baking any kind of bread. The present type of oven, designed to meet the needs of a family of four persons, consists of a box of fibrous material 19 in. wide, 17½ in. high and 18 in. deep, outside dimensions, containing two disk-heating elements 6½ in. in diameter, located at the top and bottom of an interior oven lined with glazed white fireclay and surrounded by asbestos or other suitable insulating packing. The interior oven is 12½ in. long, 8 in. high and 10½ in. wide, and has a capacity of two loaves of bread at once, set in appropriate baking pans. Each heating element is made up by the company in its laboratory and the resistance coil consists in each 50-watt unit of approximately 60 in. of Driver-Harris No. 33 nichrome wire. The wire is pressed mechanically against a fireite plate in a recess ¼ in. deep, the total thickness of the plate being ½ in. Each plate is countersunk to a depth of ¼ in. into the top and bottom of the fireclay oven and the two plates in the 100-watt cooker are electrically connected in parallel. The cooker is provided with a hinged cover with insulating material of the same kind as that used in the body of the cooker, and straps are provided with a harness clip on each, these locking the cover securely in position and preventing the escape of any noticeable amount of heat. The locked cover is not so tight, however, that steam cannot escape when liquids are boiled in the oven. The present cookers used by the company are designed to operate on a 60-volt circuit, which is used in the residences which the company supplies with tungsten lighting on a flat rate; but operation on higher voltages has been provided for.

The 50-watt cooker is cylindrical in shape, its outside diameter being 14 in. and the depth of the oven about 9 in. It consists of a 50-watt heating element of the type used in the larger cooker set into a glazed white stone jar 8 in. in diameter, which is surrounded with heat insulation, with an outside fibrous covering, and a top cover of the plunger type with felt washer, asbestos and fiber insulation. The top cover is 2 in. thick and is countersunk into the jar to permit retention of heat. In each type of cooker the fireite plate containing the heating element is sealed into the oven by retort cement. Current is supplied in each case through a flexible cord connection leading into the interior through a brass bushing in the side of the cooker near the bottom. The low energy consumption of each cooker enables it to be placed on any ordinary lamp socket without difficulty of any kind. From the first the effort has been made to produce a cooker which would be compact, portable and thoroughly sanitary. The heating element has been immersed in hot water without deterioration of the insulation. In general, the larger cooker is planned for baking, roasting and other relatively short-time service, the smaller outfit being used for stewing, boiling and other long-hour service. The company's rate for service for both cookers, used

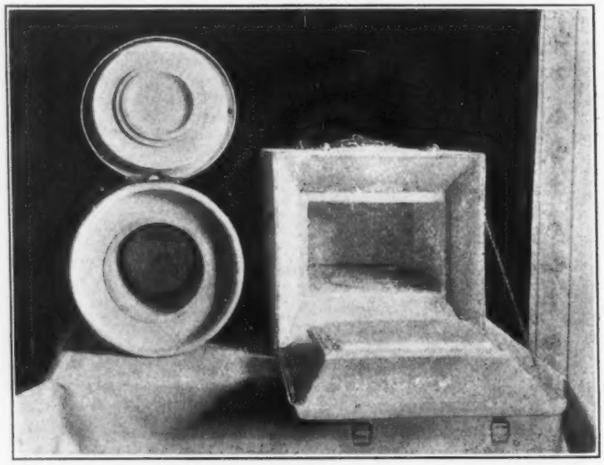


Fig. 2—Interior of Fireless Cooker.

as many hours of the day and night as the consumer requires, is to be $3 per month for families of three to five people. The main object which the company has in mind is the popularization of electricity for cooking with resultant increase in revenue from current sales.

The tests which the company has made are most suggestive, and a number of them are given below. Early in the development the company secured the services of an expert cook, a young woman well used to handling experimental problems in

dietetics. The preparation of all meals is under her charge, and the success of the fireless cooker from the standpoint of the housewife has thus been taken into consideration by one familiar with feminine requirements and capable of seeing that they are met by the company's plans for electric cooking service.

TYPICAL FIRELESS COOKER TESTS.

Test 1.		
Baking powder biscuit	100 watts	50 min.
Six cup custards	100 watts	50 min.
Roast beef, 2¼ lb.	100 watts	90 min.
Stewed tomatoes in 100-watt oven after cooking meat	100 watts	15 min.
Potatoes, cut in cubes, 35-watt cooker, 3 hours (not successful, higher heat would have been desirable.)		
Meal served to 4 persons.		
Test 2.		
Roast pork, 5 lb.	100 watts	3 hrs. 30 min.
Apple sauce, on a 35-watt unit		3 hrs.
Six cup custards	100 watts	50 min.
Baked potatoes (slightly hard, longer time preferable)	100 watts	2 hrs. 30 min.
Six persons served.		
Test 3.		
Baked bluefish, 3 lb.	100 watts	1 hr. 40 min.
Boiled potatoes (small quantity of water better)	35 watts	3 hrs.
Biscuit	100 watts	50 min.
Three persons served.		
Test 4.		
Roast lamb, 4¾ lb.	100 watts	1 hr. 45 min.
Meat pie, from previous day's Irish stew	100 watts	1 hr. 15 min.
Marble cake	100 watts	1 hr.
Tomato sauce	100 watts	15 min.
Mashed turnips and potatoes	50 watts	3 hrs.
Eight persons served.		
Test 5.		
Baked pork chops	100 watts	1 hr. 45 min.
Spinach	50 watts	1 hr. 15 min.
Apple sauce	50 watts	50 min.
Five persons served.		

Tests show that 250 deg. can easily be maintained by the 50-watt cooker.

Ham, baked beans, cereals, corned beef, meat stews, etc., are usually put in the cooker at 8:30 p. m. and left all night. At 7 a. m. they are taken out, well done. Sponge cake can be baked in about one hour in the 100-watt cooker.

In connection with the experiments of the company much has been learned about the employment of systematic methods in preparing meals on the fireless cooker. On account of the small amount of energy required to handle the work without substantial expense for current it is necessary to allow a somewhat liberal time for cooking the various articles. Hence good planning in the use of the time brings its reward, and the preparation of foods requiring a shorter time to cook while the longer-cooking foods are in the oven reduces the amount of labor materially. Thus, in the preparation of one of the company's meals the potatoes were put into the cooker (50-watt size) at 9 a. m. and left until 12. Baking-powder biscuit were put into the 100-watt oven and cooked from 9:15 a. m. to 10:05 a. m.; sponge cake was prepared in the meantime and baked from about 10:05 a. m. to 11:05 a. m., and bluefish was put on at 11:05 a. m. and finished at about 12:40 p. m. It is expected that the company's electric cookbook will contain helpful suggestions along these lines. In the cooking school ten electric ovens are to be used for demonstration purposes.

In addition to the electric cooking problem Mr. Dunham has lately taken up the question of domestic water heating for washing and other applications. Apparatus has been developed to supply water on a percolator system to a 30-gal. kitchen boiler, the water being heated by a 200-watt unit before it enters the boiler and the heat being maintained at a high level by a 100-watt unit in the bottom of the tank. An average temperature of 150 deg. Fahr., with a maximum of 190 deg. Fahr., will be maintained in the boiler, and the heating unit on the percolator is to be equipped with an automatic float switch connection which will cut current off when water is not needed. The tank will be insulated to prevent the escape of heat in excess. The company will probably make a flat rate for this service which will enable it to be used by consumers generally, and it is possible that the heater may be utilized in connection with the warming of houses by hot-water circulation.

OPERATION OF A TWO-PHASE DISTRIBUTION SYSTEM.

By Alden W. Welch.

WHERE energy is transmitted over a three-phase, 25-cycle, 6600-volt circuit two-phase current is usually obtained by use of a frequency changer consisting of a three-phase, 25-cycle, 6600-volt motor, direct-connected to a two-phase, 60-cycle, 2700-volt generator. The two windings of the generator sometimes have a common connection, but more often the two phases are entirely independent of each other. At one time it was the practice to connect the two phases in series and run a common wire from their intersection, since by

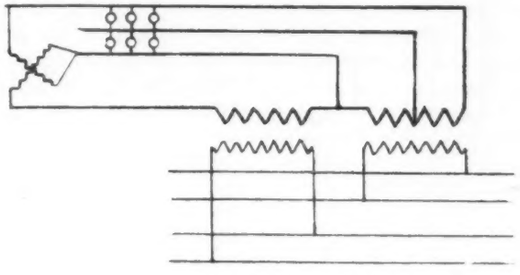


Fig. 1—Distribution Diagram.

this method three wires were sufficient, while four were required for the operation of the two phases independently. The great disadvantage of this scheme is that if trouble occurs on one phase it will affect the operation of the other. A ground on one of the outside legs will produce a strain between the other outside leg and the ground equal to 1.41 times the volts per phase. The practice now is to transmit with four wires from independent phases and distribute with three wires from either one single-phase transformer having a split winding, if single phase is desired, or from two single-phase transformers having their windings connected for two-phase service.

When a number of customers in the same vicinity using both lamps and motors are to be served with energy, it is customary to make use of a four-wire, two-phase secondary. In this case

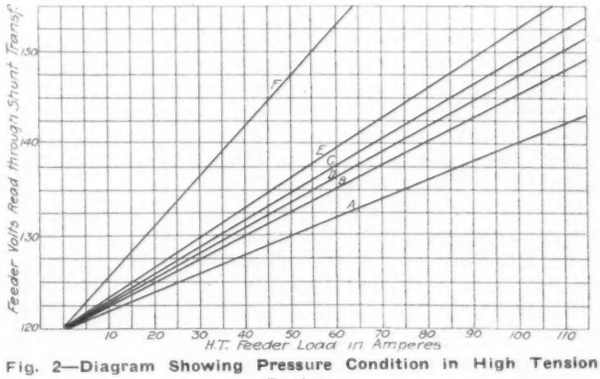


Fig. 2—Diagram Showing Pressure Condition in High Tension Feeders.

the secondary of the transformer on one phase is connected to a three-wire, 120-volt service which feeds the lamp circuits, while for the motor circuits a second transformer, connected for two-wire, 240 volts is used. One secondary terminal of this transformer is connected to one outside secondary terminal of the lighting transformer and the other terminal forms the fourth wire of the secondary circuit. The wire running from the junction of the two transformers forms the common wire for the two-phase motors, the first and fourth wire being connected to the phase terminals of the motors. Reference to the diagram will immediately make clear this method of operation. This method should not be used where the motor and lighting loads are simultaneous. The usual condition met with

is that the motors are operated during the day, while the lamps burn only at night. This maintains a balanced condition on the secondary.

The voltage is controlled by either a hand-operated or an automatic regulator. The latter method has been tried with great success, and following is a brief description of such a regulator. The control part of this apparatus is a contact-making voltmeter which consists of a solenoid having a shunt winding and a series winding acting in opposition. Mounted on a support is a lever, on one end of which are two contact points and on the other end is a core which is free to move within the solenoid. The contact points on the movable lever control the energy used in the relay switch, which in turn controls the circuit for operating the motor of the regulator.

In series with the shunt winding is a non-inductive resistance having taps for various voltages. The resistance is of such value that a current of about 0.8 amp is carried in the shunt winding. The potential tap used for two-phase feeders is usually 120 volts. The series windings are divided into seven fine and two coarse adjustment windings, each of the coarse windings having about seven times the effect of a fine one.

In calibrating the contact-making voltmeter a spring on the lever is adjusted until the lever balances between the contacts with 120 volts on the shunt winding and no current in the series coils. In order that the contact-making voltmeter may compensate for the *IR* drop on the feeder at all loads, the number of series turns is adjusted to maintain normal voltage at a time when the feeder is carrying a heavy load at a power-factor of 90 per cent until the effect of the ampere-turns due to the current is equal and opposite to that produced by the shunt coils, the lever balancing between the relay contacts.

Any increase in load on the feeder naturally increases the ampere-turns in the series coil and causes it to draw the core downward, the lever making contact on the upper stud. This operates the relay switch, causing the motor to operate the regulator in a direction to increase the voltage until the pull exerted by the shunt coil balances that in the series coil. As the load decreases on the feeders the pull in the series coil decreases and the core is drawn upward, causing contact to be made on the lower stud. This energizes the relay in the lowering position and the regulator continues to lower the voltage until a balance is again restored to the solenoid windings.

For regulating the voltage of highly inductive circuits use is made of a compensating voltmeter. This instrument compensates for the inductance and *IR* drop, and is used for maintaining a predetermined voltage at the point of distribution irrespective of load or power-factor. The regulator should be connected between the feeder switch and the series transformer so that the ammeter will indicate the exact load carried by the feeder and not include that taken by the regulator. This is essential to good voltage regulation.

The following is the method for determining at what pressure a two-phase feeder should be operated when hand-operated or motor-operated regulators are used. The feeder is covered by testers. One is usually sufficient, but for feeders extending over a large area two or more testers are necessary in order to obtain satisfactory results. Pressure readings are taken by means of an alternating-current voltmeter at the cut-outs of certain customers, the aim being to obtain a general idea of the pressure conditions in all parts of the feeder. If the voltage is found to be nearly normal over the whole feeder, especially in the districts of heaviest load, a certain customer is selected on each phase, usually in the section of the heaviest load. These two locations are termed the balancing points and it is assumed that, conditions remaining the same, when the pressure is normal at these points the entire feeder is operating at satisfactory pressure.

At the balancing points, the station from which the feeder is being operated is called up by telephone and readings are obtained of the feeder load and feeder pressure as indicated by the station instruments. From the data obtained a curve is plotted, having feeder loads in amperes as abscissas and feeder pressures as ordinates. If 120 volts is considered normal pressure at the balancing points, and when that voltage is read the feeder is carrying 50 amp high tension, at 130 volts feeder pressure at the station, read through shunt transformers, the curve would start at 0 amp and 120 volts and pass through the point on the sheet representing 50 amp at 130 volts. Two similar curves, one for each phase, are drawn on the same sheet.

If the loads on the two phases are nearly equal and correspondingly distributed, the two points representing the respective loads on the two phases should be plotted and a curve drawn bisecting the space between these points. The curve so determined should be used for operating both phases. If the loads on the two phases are not evenly distributed, curves of both phases should be plotted on the same sheet. Under these conditions the two phases of the feeder would be regulated by different curves.

Curve *A* represents the previously mentioned condition when the conditions affecting the operation of the two phases are equal. Operating curves *B* and *C* do not coincide with each other, but the difference between them is so slight that curve *D* may be drawn bisecting the space between them. *D* now becomes the operating curve for the feeder, *B* and *C* being erased. With conditions on the feeder such that the phase curves assume the positions *E* and *F* it would be necessary to retain both curves and operate each phase by the curve corresponding to it. All the curves start at 120 volts, which represents normal pressure at the customer's cut-outs.

With a hand-regulated feeder the operator reads the load on each phase and by consulting the curves finds at what pressure the feeder should be operated. When the load changes he raises or lowers the pressure to correspond. When automatic regulators are installed the curve is used for setting the contact-making voltmeter to operate at normal voltage at the balancing points. A general test should be made over the feeder about once a month.

It has been suggested that small shunt transformers be installed at selected points on the feeder and pressure readings taken at the secondaries of these transformers instead of at the customer's cut-outs. By this method the actual pressure of the feeder at a given point would be obtained. With the present method the feeder pressure often appears to vary on the same phase within a few hundred feet. This is due to the load conditions on the various transformers. The writer recalls one case in which there were three customers on the three corners of a certain street fed by three individual transformers connected to the same phase. Two installations were being supplied with current at 120 volts, while the pressure at the third was 110 volts. An investigation showed that the low pressure was caused by the aged iron of the distributing transformer. The scheme of using the small independent transformers for reading the line voltage has much to commend it.

REMOTE CONTROL OF MOTOR DRIVE IN CHICAGO GRAIN ELEVATOR.

The large grain elevator of the Interstate Elevator Company, at Fiftieth and Wallace Streets, Chicago, is equipped with and driven throughout by fifteen induction motors aggregating more than 500 hp. This elevator was formerly operated by steam, but was converted to electric drive at the time of elevating the Erie tracks near which it stands. Three-phase, 60-cycle energy at 6600 volts is obtained from the power plant of the Indiana Railroad Company, a quarter mile distant, which also lights the yards and subways of several railroads, including the Polk Street terminal.

The motor equipment of the elevator comprises fifteen motors, totaling 525 hp. A 75-hp motor, arranged with gears, friction clutches, cable drums and rheostatic control, is used to move railroad cars into place for loading and unloading. A 30-hp motor drives the shovel shaft, on which are mounted drums winding up ropes which drag large flat boards or shovels

across the floors of the cars, pushing the grain into chutes at the doors. These shovel drums are arranged with friction clutches operated by counterweights, which allow the shovel boards to be carried back into position before winding begins. Small drums on the shovel shaft may also be used for adjusting the position of cars. There are three 50-hp motors driving the elevating bucket-belt conveyors and four 40-hp motors operating the oat clippers. Two 10-hp motors drive grain separators and a 30-hp motor is employed to operate the bleacher. The dust is blown from the dust house by two 15-hp motor-driven draft fans. A 30-hp motor-driven emergency fire pump is also provided, as the elevator building is separated by the railroad yards from the street and is inaccessible for fire protection.

The starting apparatus for all of the fifteen motors is concentrated in a switchboard installed in a brick building separated from the elevator structure by fire walls and steel doors. The transformers stepping down the transmission potential, 6600 volts, to the motor pressure, 440 volts, are mounted in a concrete compartment in the basement of the switch-house.

When one of the workmen out in the elevator structure desires to have a machine started he pushes the battery bell-button at the motor. This rings a bell on the switchboard and throws the corresponding indicating arrow on an annunciator. The switchboard attendant answers this signal to show that it is properly received by pushing a button on the switchboard which rings a battery bell at the motor. He then throws the motor switch into the starting position, holding it there until a two-ring signal is received from the man at the motor-driven machine, indicating that the motor has started properly and has reached a speed where it can be thrown over to the running position. This two-ring signal received, the starting switch is thrown over to the full running position and the switchboard attendant's duty ends.

To enable the man running the machine to shut down the motor when he is through operating it, the 220-volt trip-coil circuit of the circuit-breaker controlling this motor is carried in conduit to a push button mounted near the starting signal button at the motor. Depressing this button energizes the trip coils of the circuit-breaker, opening it and stopping the motor.

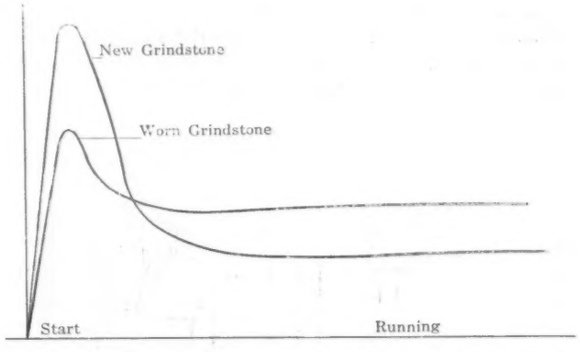
Several of the large motors in the elevator are on the upper stories and others are installed in the basement. All of these, however, are satisfactorily started and controlled by the method in use. This electrical equipment has been installed several years and has given the best of service. The necessity for isolating the starters from the elevator structure was in accordance with the Underwriters' requirements, as it was deemed hazardous to permit oil switches or sparks in the dust-laden air of the elevator. The car-shift motor with its rheostatic controller is installed in the switchroom, where it can be manipulated by the switchboard attendant.

VARYING STARTING AND RUNNING TORQUES DURING LIFE OF MOTOR-DRIVEN GRINDSTONE.

A peculiar problem is presented to the engineer who has to specify the size and characteristics of a motor to drive a grindstone. When new a large heavy grindstone will require a high starting torque to accelerate its great mass, but after it is under way the power required to do intermittent grinding will be comparatively small on account of the large flywheel effect of the rotating mass. The power of the motor, delivered continuously to the stone, is drawn upon only intermittently by the grinding tool, so that a smaller motor than otherwise necessary will be sufficient. But as the wheel wears the reverse of the above relation between starting and running torques takes place.

To accelerate the small, worn grindstone very much less starting effort is required, but this decrease of flywheel effect results in demanding a motor rating practically equivalent to the power intermittently used at the grinding tool. The choice of a motor to be permanently installed for grindstone drive must therefore involve the considerations of both high initial torque and good efficiency and power-factor on light loads.

In equipping the factory of the B. Herschel Manufacturing Company, Peoria, Ill., for electric drive from the lines of the Peoria Gas & Electric Company, eight 4500-lb. grindstones have been arranged for electric drive and fifteen others in the same plant will be similarly equipped. The Herschel company manufactures blades and teeth for agricultural machinery and uses a large number of these stones for finishing the grinding



Starting and Running Torques of New and Worn Grindstones.

of its products. When new the 4500-lb. grindstones are 14 in. wide and 6 ft. in diameter and are run at about 250 r.p.m. As they become worn the pulleys are changed four or five times, keeping the peripheral speed of the stone practically constant during service. When the stones reach a diameter of 14 in. they are discarded and new ones substituted. Upon investigation of the starting demand of a new stone it was found that during a period of ten seconds the power taken amounted to 30 kw. As the grindstone got under way the power to supply the friction and grinding load fell below 10 hp or 12 hp. An old stone, however, showed a power demand of at least 15 hp to drive it at rated speed while working. The motors finally chosen for the operation of these stones were 15-hp, 440-volt, 60-cycle, three-phase Westinghouse HF phase-wound machines, which develop a high initial starting torque well suited for this work. The eight grindstones at present driven by these motors are operating with entire satisfaction, and, as above noted, fifteen additional stones are to be similarly equipped.

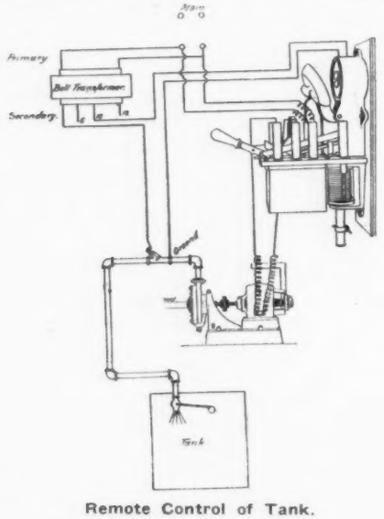
AMPERE-HOUR METERS FOR CONTROLLING ELECTROPLATING.

An interesting use of the amp-hour meter, developed principally for reading battery input and discharge, is the arrangement of such a meter with a scale marked in pounds of copper, ounces of silver, or units of any other plating metal, so that when the meter is placed in series with an electroplating bath the exact quantity of metal deposited can be read directly without examining the plated piece. The amp-hour meter hand is arranged with a set-back attachment so that it can be started from zero at the beginning of each plating operation. Several large silver-plating concerns which have had amp-hour meters in service for a year or more report that with the large batches of work in their electroplating baths the reading of the meter has attained an accuracy over 99.5 per cent of the actual deposits by weight. A contact piece on a movable hand makes it possible to operate a circuit-breaker and stop the plating operation after a given weight of metal has been deposited.

LETTERS ON PRACTICAL SUBJECTS

REMOTE CONTROL OF WATER TANK.

The following scheme for controlling the water supply to a distant tank may be of interest. The equipment consisted of a 4-hp Wagner motor direct-connected to a three-stage Morris pump delivering water to a tank of 3000 gal. capacity three-quarters of a mile away, through a 2-in. feed pipe running overhead. The pipe line had a ball-cock stop valve in it and the intention was to connect to this installation a circuit-breaker, so that when the tank became full the ball-cock valve would close, the flow of water cease, the load drop off and the circuit-breaker open. This scheme, however, did not work out as well as was anticipated, due to the fluctuations in the main line from which the supply was taken. The following scheme was



Remote Control of Tank.

then tried: A 2-in. horizontal check valve was put in the discharge line with a spark plug in the cap, so that when the flap valve was open contact was made to the center part of the spark plug, thus closing the circuit of a small bell-ringing transformer. To one of the low-voltage leads of the transformer was connected a circuit-breaker rewound for 12 volts, and the other lead was grounded as shown in the engraving herewith. Now, when the tank became full the ball cock closed the discharge line and stopped the flow of water. The check flap thereupon dropped and opened the circuit of the 12-volt line, which released the circuit-breaker and thus opened the circuit. The plan worked well and the scheme can doubtless be applied for many other purposes.

Tuxedo, N. Y. H. Lake.

GREASE LUBRICATION.

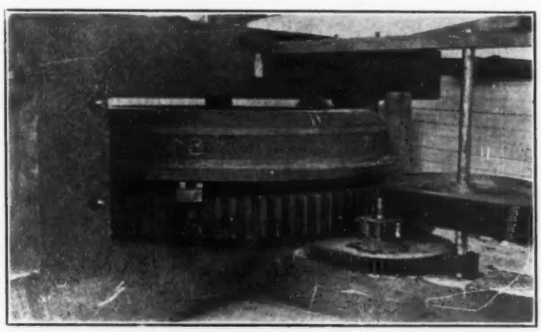
In small or medium-size power stations where it is not profitable to install a gravity lubrication and filtering system the matter of satisfactorily oiling all the machinery bearings at a low cost for oil and labor often assumes proportions far beyond its seeming importance. Consequently the oiling system is usually found to be very crude in small plants, often neglected entirely by the designer and left entirely to the engineer and his squirt can. Persons who have ever had anything to do with running machinery, and especially fast-running electrical machinery, are well aware of the destruction caused by insufficient or neglected lubrication. The science of lubricating engineering has been developed to such an extent that there is no need of or excuse for either high friction cards or badly worn bearings, provided a little attention be given to the matter of lubrication by the owners or manager of the plant. The engineer cannot install a suitable lubricating plant all by himself, even though he is willing and anxious to do so. He must have the support and encouragement of his employers in order to add so much to the equipment of the station. But there are a number of things which the engineer can do upon his own responsibility which will greatly increase the efficiency of the lubrication at a very slight expense. He can obtain a supply of compression grease cups and apply them to bearings where there are open oil holes. The compression grease cup filled with some good grease is no mean lubricator, and for the small plant the compression grease cup leaves little to be desired. All that is necessary for applying compression grease cups is to tap a hole in the bearing, using a ¼-in. pipe tap for that purpose, then screw in the grease cup, and the whole thing is done except the filling of the cup with good grease and the periodical screwing down, a little at a time, of the cover of each cup. Right here is where the oiler usually goes wrong. He screws down the grease-cup covers too much and forces far too much grease into the bearings. If one would investigate the matter a little he would see what happens when the cover of a 2-in. grease cup is given ¼ in. of movement. The area of a 2-in. cup is 3.14 sq. in. and with sixteen threads to the inch the compression would be one-twenty-fifth of one-sixteenth, or 1/400 in. This advance of the cover would squeeze out 0.0078 cu. in. of grease. This makes quite a drop and enough to lubricate a good deal of shaft bearing, so that when an engineer is seen to screw down a cup cover a whole turn or even two turns at a time one may be certain that he is wasting good grease. Moreover, the grease will work out of the bearing and ornament beams or the floor to the detriment of the appearance of the station. It is remarkable how little grease is actually required thoroughly to lubricate a large shaft bearing. The great majority of bearings are overlubricated, and the writer has investigated cases of excessive oil bills where it was found that the machinery would actually run safely and well on one-tenth of the lubricant applied and wasted in and around the journal bearings. True, there cannot be too much oil or grease applied to a bearing as far as proper lubrication is concerned—splash and submerged lubrication proves this—but there is a big difference between using and wasting a lubricant. The grease cup is very convenient for lubricating bearings which are located in obscure places hard to reach with an oil can. In cases of this kind it is very easy to pipe the oil hole to a convenient place and then add a coupling and a compression grease cup. Grease may be forced through very long pipes in this way, but care should be taken in the arrangement of the pipe, or else much grease may be wasted in certain cases. For instance, when a pipe extends upward a considerable distance above the level of the bearing, should a bearing thus connected become warm or hot enough to melt the grease in the connecting pipe there will be a flow of grease or oil of altogether too liberal a character, and the bearing is liable to be flooded with grease or oil until the contents of the pipe have been melted out so far back that the heat cannot reach more grease. To avoid a possible occurrence of this character the pipe connecting the grease cup with the bearing should lead downward as soon as it leaves the journal bearing for a distance as great as heat can be transmitted by the pipe. There is a limit of length for each size of pipe beyond which heat will not go, and that limit is where the heat in the grease pipe is lost by radiation into the atmosphere. After this length has been exceeded by a pipe leading downward, then the pipe may be led upward, quickly or gradually, until the cup is at the desired location. With the grease pipe arranged in this manner there will never be any loss or waste of lubricating material through undue melting of the grease. When two bearings are located close together the writer has occasionally arranged both to feed from a single grease cup, the pipes from the bearings being joined together into a third pipe leading to the grease cup. But where such an arrangement is used some means must be provided to prevent all the grease passing through one of the pipes while the other gets nothing. This may be done in more than one way. The writer finds it convenient to place a tee in each branch pipe

and then thread a plug so it will reach to the bottom of the hole in the branch of the tee, thus nearly or quite closing the opening through the tee. An ordinary pipe plug will not answer for this, as it is too short to reach to the bottom. It is best to thread a bit of solid rod of the requisite diameter, then bend the end of the rod for a handle, or forge it flat like the end of a thumb-screw. This arrangement may be adjusted at will until each branch receives the precise amount of grease it is desired to send out, and a slight movement of the plugs will permit the proportion of grease sent to either bearing to be changed at will.

South Bend, Ind. JAMES F. HOBART.

HOME-MADE 6-FT. BORING MILL.

The resourcefulness of the erecting engineer is proverbial, for all have some pretty tough problems to tackle that the "slip-stick" fellows in the design office overlook; problems that keep them from spending much time enjoying the scenery in the far-away places where they have to put machinery together and make it work. The construction of a 6-ft. boring mill with hammer and saw, and with what pieces of machinery could be scratched up in a mining town 3000 miles from the factory, should be of interest and the accompanying photograph shows how it worked. While installing a water-power plant in a British Columbia settlement to which the mail came once every two weeks, the writer discovered that the finishing of the case side-plates of the water-wheels had left insufficient room for the runner inside to clear the casing. This error had not been noticed in the factory erection department, but it was felt that at least 0.5 in. additional space would be required on either side. The next problem which presented itself was how to get that ½ in. taken off of the casings, which were nearly 6 ft. in diameter. Of course, they might have been shipped back to the nearest civilized machine shop, but that would have caused two



Home-Made Boring Mill.

months' delay at a time when we were already behind in our erection. So it was determined to take that ½ in. off in a boring mill of our own construction, and we set about finding material with which to build it. This search was a disheartening one after the first fifteen minutes, during which I visited the mine-plant headquarters and looked over their stock of machinery. But the next day I happened to run across an old gear wheel down the valley that had been taken from an abandoned shaft. It was 6 ft. in diameter and weighed several tons, but, convinced that it would make an ideal stage for my boring mill, we laboriously hauled it to the plant. Here we fixed it on a shaft borne between two horizontal timbers for a frame and rigged up some other small gears to drive it from a pulley belted to a steam-engine shaft. Hook bolts were also made to secure the turbine plate to the gear spokes, and the cutting tool was bolted into place on one of the uprights supporting the cross-pieces. Of course, the finished boring mill worked like a charm and after getting it together it was only a day or two before the side plates were completed and in their places, with as smooth a finish as ever came out of the factory itself.

Chicago, Ill. JOHN R. READING.

A METHOD OF TESTING AN ELECTRIC MINE HOIST.

The object of this article will be to give a method of testing an electric hoist for the purpose of making analysis of the losses and of the power required to drive the equipment.

One of the special cases to which this method of testing is particularly adapted is in testing old hoists which have been changed over from steam to electric power and on which there are no available data.

Consider the case of a single cage, without a counterweight, the rope drum and hoist being driven by an induction motor. Assume that the depth of the shaft, the size or weight of the rope, rope speed and weight of the cage are not known. By connecting an indicating wattmeter in the circuit of the motor and taking four readings, noting the time between readings and number of revolutions of the drum, all of the above unknown quantities can be calculated. The writer has made several similar tests and has found that the results calculated from the tests do not vary more than 2 per cent from the correct values.

In order to illustrate how these tests are conducted and the accuracy of the computed values, the results and calculations of an actual test will be given.

Let L equal loss load in kilowatts, or the power lost due to the friction of the hoist drums, motor friction load and iron and copper losses in the motor; Ca equal the power necessary to lift the weight of the cage at its normal hoisting speed; R equal the power necessary to lift the weight of the rope which is suspended in the shaft. Four readings are then taken, the readings for convenience being designated as A, B, C and D. Reading A is taken when the cage is at the top of the shaft and just as it is starting down. Reading B is taken just before the cage arrives at the bottom of the shaft and before the power is shut off. Reading C is taken while the cage is running up and as soon as the controller is on the last notch, but not until the motor is up to speed. Care is taken in getting this reading to see that no power is registered on the wattmeter due to the acceleration of the equipment. Reading D is taken just before the cage arrives at the top.

These four readings can be expressed algebraically as follows:

A = Starting down $= L - Ca$; B = Arriving down $= L - Ca - R$; C = Starting up $= L + Ca + R$; D = Arriving up $= L + Ca$.

On one of the equipments tested the following values were obtained:

$$A = -10.2;\ B = -11.8;\ C = 19.4;\ D = 17.8.$$

The values of A and B are given the negative sign because the motor was acting as an asynchronous generator and feeding energy back in the line.

Subtracting D from C gives $R = 1.6$ kw, or 2.14 hp.

The depth of this shaft was 450 ft. and the time between readings C and D was four and one-half minutes, so that the rope speed was 100 ft. per minute. Knowing the rope speed and the horse-power required to lift the rope from the bottom of the shaft the weight of the rope can be figured as follows:

$$\text{Rope weight} = \frac{2.14 \times 33{,}000}{100} = 707 \text{ lb.}$$

707 lb. divided by 450 ft. = 1.57 lb. per foot. Upon referring to a steel rope table it was found that 1-in. rope weighs 1.59 lb. per foot.

Adding A and D it is found that $2L = 7.6$, or $L = 3.8$ kw $= 5.1$ hp. Substituting this value of L in equation D, Ca is found to equal 12.7 kw $= 17$ hp, and the weight of the cage is

$$\frac{17 \times 33{,}000}{100} = 5600 \text{ lb.}$$

Although no two of the above four equations have the same value, it is interesting to note that the difference between equations A and B should be equal to the difference between equation C and D, and in each case this value is the rope kilowatt. Moreover, the difference between A and D is equal to the difference between B and C, and is equal to twice the losses. If these checks do not hold true some mistakes have been

made and other readings should be taken in order to determine the discrepancy.

The writer has also used this method for testing elevators and mine hoists on which the cage is counterweighted. In this case the equations are as follows:

$A = L - Ca + Cw + R$; $B = L - Ca + Cw - R$; $C = L + Ca - Cw + R$; $D = L + Ca - Cw - R$.

In the above equation Cw equals the power necessary to lift the counterweight at its rated speed. As it is neither necessary nor possible to determine the separate weights of the cage and the counterweight from the above equations, let $Ca - Cw =$ difference, or the power in kilowatts required to lift the difference between these weights.

A mine hoist upon which there were no available data was tested by this method and the values obtained for the various wattmeter readings were as follows:

$A = L - \text{Diff.} + R = 24$ kw; $B = L - \text{Diff.} - R = 8.8$ kw; $C = L + \text{Diff.} + R = 28.4$ kw; $D = L + \text{Diff.} - R = 13.2$ kw.

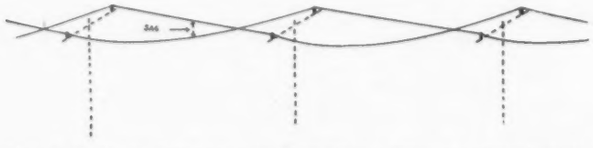
Solving, it is seen that $2R = 15.2$ kw, or $R = 7.6$ kw $= 10.1$ hp The rope speed was 500 ft. per minute, hence $(10.1 \times 33{,}000) \div 500 = 668$ lb. $=$ weight of one rope. Subtracting B from D gives: Diff. $= 2.2$ kw $= 2.93$ hp. And $(33{,}000 \times 2.93) \div 500 = 193$; or the cage was found to weigh 193 lb. more than the counterweight. Additional counterweight of 1000 lb. was added and another test showed that the cage was about 800 lb. heavier than the counterweight. Adding B and C it is found that $2L$ equals 37.2 kw, or $L = 18.6$ kw $= 24.7$ hp.

It is evident that a condition might exist when in lowering the cage the motor would take energy from the line and after enough rope had become lowered in the shaft to overcome the friction the motor would become an asynchronous generator and put energy back in the line. Such cases are often met with and the wattmeter must be closely watched in order to give the values a negative sign in case the motor is acting as a generator. If the cage is over counterbalanced this condition may exist when the cage is running up the shaft.

Scranton, Pa. A. S. Biesecker.

SIMPLE METHOD OF TRANSPOSING WIRES.

This scheme of transposing a pair of telephone wires at every pole of the transmission line along which they are carried is certainly so simple as to have deserved better attention from engineers who design lines and use instead the unsatisfactory double-groove transposition insulator or four-insulator construction. The method consists in rotating the circuit by crossing wires between poles, allowing the lower wire several feet more sag than the other. In a line carried on pins 3 ft. apart and hung in 600-ft. spans, 3 ft. difference in the sags of the crossing wires has proved an entirely satisfactory and permanent construction. The wires cannot swing together and



Simple Method of Transposing Telephone Wires on Transmission Towers.

make contact, for at the middle of the span, where the tendency to swing is greatest, the wires are correspondingly most widely separated. In a line of any length the unsymmetrical suspension of the wires is compensated since each wire occupies alternately the long and short sag position. The only provision to be made in using this construction is that the wires do not slip on the insulators or the latter rotate under the unbalancing action of the unequal spans, letting the wires get together.

Cameron, Wis. P. F. Larned.

THE DISTINCTION BETWEEN TORQUE AND WORK.

Because of the fact that many writers and engineers erroneously express units of both work and torque in foot-pounds, a confusion sometimes exists regarding the distinction between the two. As will be shown, work is properly expressed in foot-pounds (ft.-lb.), while torque should be expressed in pounds-feet (lb.-ft.), or preferably in pounds at a given radius.

Work is the overcoming of resistance through a certain distance. It is measured by the product of the resistance into the distance through which it is overcome. It is also measured by the product of the moving force into the distance through which the force acts in overcoming the resistance. Therefore if, as suggested in Fig. 1, a weight of 50 lb. is raised through a distance of 100 ft. the work done is $50 \times 100 = 5000$ ft.-lb.

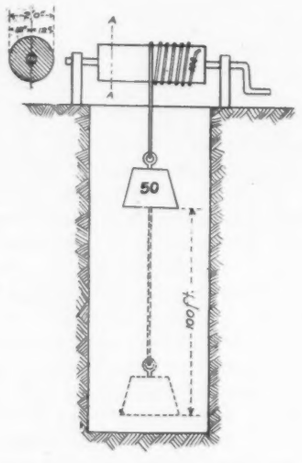


Fig. 1—An Example of Work and of Torque.

Torque is the measure of the tendency of a body to rotate. It is the measure of a turning or twisting effort. Torque may exist even if there be no motion. Thus, in Fig. 1, the torque at the circumference of the drum is 50 lb. whether the drum be moving or standing still. It is assumed that the hoisting rope has no weight. Torque is sometimes expressed as the product of the force introducing the tendency to rotate times the distance from the center of rotation to the point of application of the force. For instance, in Fig. 2 the torque tending to turn the cylinder in the brick wall would be $100 \times 12 =$

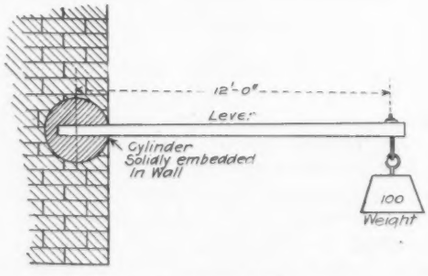


Fig. 2—An Example of Torque.

1200 lb.-ft. (In some textbooks this would, inaccurately, be expressed as 1200 ft.-lb.) The cylinder cannot turn and no work could be done. Therefore, it is incorrect to express this tendency to rotate in foot-pounds, which is the unit of work. Probably the most preferable way of expressing the torque in this or in any example is in terms of pressure (or force) and radius. Thus: "100 lb. force at 12 ft. radius." Ordinarily the expression is given for unit or 1-ft. radius. Then, for the case of Fig. 2, the torque would be 1200 lb. at 1 ft. radius. Summing up, work should be expressed in foot-pounds.

Torque, although it is, erroneously, sometimes expressed in foot-pounds, should always be expressen in pounds-feet, or preferably in pounds of force at a given radius. There can be torque where there is no work. Applying the principles outlined above to a motor under test for output, the power delivered being measured with a prony brake, Fig. 3, may be taken as an example. The torque is 10 lb. at 3 ft. radius, or 30 lb.-ft., or 30 lb. at 1 ft. radius. Since the motor pulley is turning at the rate of 1000 r.p.m. a point on its circumference travels $2\pi rR = 2 \times 3.14 \times 1 \times 1000 = 6280$ ft. per minute. At its circumference the pulley is overcoming a resistance of 30 lb. Therefore it is doing work at the rate of $30 \times 6280 = 188{,}400$ ft.-lb. per minute. Since, when work is done at the rate of 33,000 ft.-lb. per minute, a horse-power is developed, the motor is delivering $188{,}400 \div 33{,}000 = 5.7$ hp. It should be noted that, though the torque at the circumference of the motor

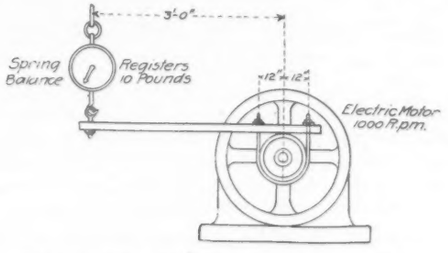


Fig. 3—Torque Registered with Prony Brake.

pulley was considered in the example, it is not necessary to take the torque at that point. The torque may be taken at any point if the radius to that point is used instead of he radius of the pulley. The formula for determining the horse-power output of a motor under test with a prony brake is

$$\text{hp} = 2 \times \pi TS \div 33{,}000,$$

where $\pi = 3.1416$, T = torque in pounds-feet and S is the speed of the motor in revolutions per minute. Substituting the values from the above example in this formula:

$$\text{hp} = 2 \times 3.14 \times 30 \times 1000 \div 33{,}000 = 5.7 \text{ hp.}$$

This is the same result secured by the former and longer method. In metric units work is expressed in kilogram-meters, so, conversely, troque should be expressed in meter-kilograms or in kilograms at a given radius in meters.

Pittsburgh, Pa. FRANCIS BUNNELL.

DETERMINING THE POWER-FACTOR OF A THREE-PHASE CIRCUIT.

Among men employed by operating electric companies there are many who know that methods exist by which the power-factor of a three-phase circuit or installation may be determined, but comparatively few are able to apply them successfully. Many errors made in meter connections due to the effect of low power-factor on the registration of single-phase watt-hour meters (or wattmeters) or separate elements of polyphase meters on three-phase circuits are directly traceable to the lack of knowledge of the points brought out in the accompanying illustrations. Figs. 1 and 2 are copies of instruction sheets furnished by one operating company to its employees where induction-motor installations are the rule. These sheets have been reproduced here with the hope that some seeker after knowledge will be benefited. Fig. 1 in the well-known power-factor curve for two single-phase meters on a polyphase circuit. It also gives a small diagram of simple connections in addition to a few words of instruction with reference to the use of the curve. As the figure stands it should be self-explanatory. Fig. 2 gives, first, a method of checking results obtained by employing the curve given in Fig. 1, as well as a diagram of the connections to be used in obtaining data for the check. This part of Fig. 2 should be easy to apply. The second part of Fig. 2 gives a detailed method of determining the correct connections of two single-phase meters, or one polyphase meter, on a three-phase circuit. If this part of Fig. 2 is employed with care errors in meter connections on three-phase circuits due to the power-factor being near 50 per cent should be a minimum.

To illustrate the use of the above instructions, an actual case will be taken: A 100-hp, three-phase, 440-volt induction motor was operating on 30 per cent full load or 40 hp (29.8

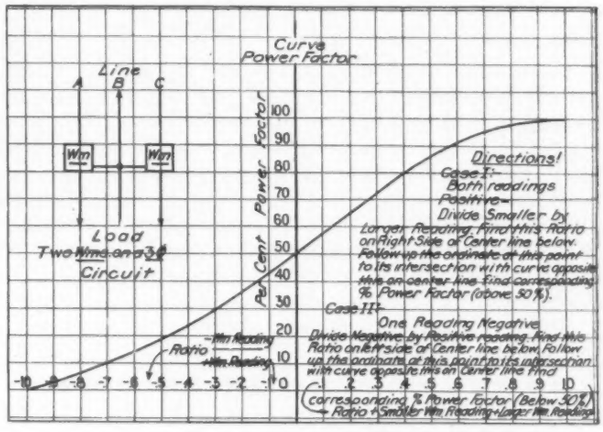


Fig. 1—Power-Factor Curve.

kw) at 60 per cent power-factor (afterward determined) when an order "came through" to place a polyphase meter on the installation. Immediately after the meter had been connected in circuit the following question was asked: "Should the light element add to or subtract from the heavy element; that is, is the power-factor above or below 50 per cent?" As the meter leads were incased in pipe, these could not be traced, therefore the instructions in the second figure pertaining to this point were applied. The connected load of the motor having been thrown off, it was found that one element of the

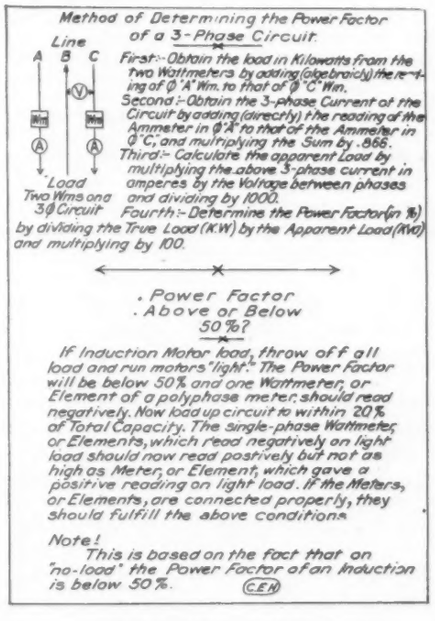

Method of Determining the Power Factor of a 3-Phase Circuit.
Line
A B C
Wm
Wm
Load
Two Wms on a 3ϕ Circuit
First:- Obtain the load in Kilowatts from the two Wattmeters by adding (algebraically) the reading of ϕ "A" Wm. to that of ϕ "C" Wm.
Second:- Obtain the 3-phase Current of the Circuit by adding (directly) the reading of the Ammeter in ϕ "A" to that of the Ammeter in ϕ "C", and multiplying the Sum by .866.
Third:- Calculate the apparent Load by multiplying the above 3-phase current in amperes by the Voltage between phases and dividing by 1000.
Fourth:- Determine the Power Factor (in %) by dividing the True Load (K.W.) by the Apparent Load (KVA) and multiplying by 100.
. Power Factor
. Above or Below
50%?
If Induction Motor load, throw off all load and run motors "light". The Power Factor will be below 50% and one Wattmeter, or Element of a polyphase meter, should read negatively. Now load up circuit to within 20% of Total Capacity. The single-phase Wattmeter, or Elements, which read negatively on light load should now read postively but not as high as Meter, or Element, which gave a positive reading on light load. If the Meters, or Elements, are connected properly, they should fulfill the above conditions.
Note!
This is based on the fact that on "no-load" the Power Factor of an Induction is below 50%.
C.E.H.

Fig. 2—Chart of Instructions.

meter gave a negative reading. Sufficient load was then put on to bring the motor to about 80 per cent of its full-load rating. Each element of the meter (taken separately) now read positively, but the element which on no-load gave a negative reading on 80 per cent load read lower than the heavy element. The meter had been correctly connected when installed. Later both methods given in the above figures to determine the power-factor of a three-phase circuit were applied and both gave approximately 60 per cent (at 30 per cent load), as previously stated.

Los Angeles, Cal. C. E. HOWELL.

QUESTIONS AND ANSWERS

Have any data been published on the number of meters installed in average towns or is there any approximate average percentage of electric light customers to population in cities of different classes? F. B.

Considerable information concerning the probable number of meters in various towns and the approximate average percentage of electric light consumers to the population in cities of different classes has been given in our columns at various times. The reports given covered a total of fifty towns. From these reports it appears that the average number of meters per 100 of population is about eight. The average number of residence meters per 100 of population in Ohio seems to be about five.

Kindly advise me how to determine the power-factor of a three-phase line by the use of two wattmeters. W. P. T.

In measuring power in any three-phase circuit, it is essential to employ two single-phase wattmeters. That is to say, if the leads be marked *A*, *B* and *C*, one of the wattmeters could be connected with its current coil in lead *A* and its voltage coil across between this lead and lead *B*. The other wattmeter could be connected in lead *C* and with its voltage coil across between this lead and lead *B*. The sum of the readings of these two wattmeters would be the true power in the circuit. When the power-factor is less than 50 per cent, one of the wattmeters will give a negative reading, which means that under these conditions the true power is represented by the difference between the readings of the two wattmeters.

We have experienced excessive heating in the wires of a three-phase, 440-volt, 60-cycle motor circuit, each wire of which is contained in a separate iron conduit. The conduits were bonded together and grounded with no apparent decrease in the heating. Would the inductive effect in about 150 ft. of such conduit be great enough to cause a temperature rise? Would this method of distribution be considered good engineering practice in polyphase work? Could a 5-hp, 500-volt direct-current, series-wound, four-pole motor, be made to operate with any degree of success on a 220-volt, 60-cycle circuit as a repulsion motor? About what power might be expected under these circumstances? F. D. M.

It is very bad engineering practice to run the three wires of a three-phase circuit in separate iron conduits, and we fail to see how the installation could ever have passed the Underwriters' inspector. The Code is very explicit in stating that all the wires of the same alternating-current circuit must be placed in the same conduit. By making this change your heating will disappear, if the wires are large enough. The ordinary form of direct-current motor with projecting field poles is not suitable for use as a repulsion motor. A motor of the repulsion type should be provided with a continuous magnetic circuit. Unless the circuit is continuous the machine will require an excessive amount of current for magnetization, and hence the power-factor will be extremely low and the performance unsatisfactory, if, in fact, the machine can be operated at all. It is to be noted in this connection, however, that a machine provided with a continuous magnetic circuit, such as is usually the case with a repulsion motor, can be operated as a direct-current motor with even better results than are obtained from the ordinary direct-current machine.

It is desired to transform from three-phase current to single-phase through a three-phase transformer. If two of the windings of the secondary be joined as for star connection and the third winding reversed, what output will be obtained, and will such a system unbalance the three-phase line? M. B. L.

It is not practicable to transform from balanced polyphase to single-phase by means of stationary apparatus of any kind. The energy supplied from a balanced polyphase system is practically continuous, while the energy supplied in a single-phase system is fluctuating. On this account it is necessary to insert some energy-storing medium between the polyphase system and the single-phase system if the polyphase load is to remain balanced. Energy storage by stationary apparatus is extremely costly, on account of the fact that very little energy can be stored in a magnetic field or in an electrostatic field. The secondaries of three transformers the primaries of which are connected in star, when joined to a three-phase system, can be arranged to provide energy for a single-phase load, but the load on the polyphase system will necessarily be unbalanced. The best arrangement would be that in which two of the windings are joined in series to produce an electromotive force equal to 1.73 times that of one coil, and the third coil is entirely omitted. Evidently the load will then be taken off only two of the phases, and the third phase will be without load.

Two pieces of apparatus were connected in parallel on a 25-cycle circuit. One had a resistance of 50 ohms, a capacity of 0.00002 farad and an inductance of one henry. The other had a resistance of 20 ohms, an inductance of 0.5 henry and zero capacity. From the data given the impedance $Z = 126.3$ ohms and the angle of phase difference was computed to be 52 deg. 36 min. When the actual resistance of the circuit was obtained from the formula $R = 1 \div \left(\frac{1}{r} + \frac{1}{r_1} + \ldots\ldots\right) = 14.28$ ohms it differed widely from R when obtained from the formula $R = Z \cos \phi = 76.74$. Why should this be?

It is not possible to add together directly the reciprocal of the resistances of several alternating-current circuits placed in parallel in order to find the equivalent resistance of the resultant circuit. This fact can be best appreciated by dealing always with currents rather than electromotive forces when treating parallel circuits. That is to say, one should consider conductance rather than resistance in solving problems relating to parallel circuits. Take, for example, a circuit composed of one ohm resistance in series with one ohm reactance. The impedance of the circuit is 1.4 ohms, the angle of lag is 45 deg., and the power-factor is 70.7 per cent. The impedance of the circuit being 1.4 ohms, the admittance is 0.707 mho and the conductance is 70.7 per cent of the admittance, which is 0.5 mho. The reciprocal of the resistance, as you will note from the above, would have been 1 mho, while the conductance is only one-half of this amount. These facts are discussed at great length in Dr. C. P. Steinmetz's book on "Alternating Current Phenomena."

When a choke coil is placed in an alternating-current arc lamp circuit does it use up the voltage as the resistance does in a direct-current lamp or does it back up the electricity in the wire something like a dam backs up the water in a stream? We are contemplating purchasing an alternating-current arc lamp to be used on a 110-volt circuit and the arc operates at 70 volts with 4 amperes. If the 10 volts are lost in the choke coil and magnets, does the lamp take 110 times 4, or 440 watts, or does it take 80 times 4, or 320 watts? P. H. C.

The so-called choke coil placed in an alternating-current arc lamp circuit consumes voltage in a manner somewhat similar to the resistance used with a direct-current lamp, but the relations are quite different. The choke coil is so arranged that it produces about itself a considerable magnetic field. This field alternates with the current and produces in the conductor a counter voltage. It is this voltage which tends to reduce the current with the alternating-current lamp, just as does the lost voltage in the resistance used with the direct-current lamp. It is not possible to add directly the magnetic voltage across the choke coil to the voltage consumed by the lamp to obtain the apparent sum of the two on the circuit. For example, if the lamp consumes 70 volts and the choke coil consumes 70 volts, when the two are connected in series the total voltage required is slightly less than 100 volts. The choke coil is much more economical than the resistance device used with direct current. It is possible to use resistance with an alternating-current lamp just as is done with a direct-current lamp, but it is preferable to use a choke coil on account of the improved economy.

Central Station

Management, Policies and Commercial Methods

GOOD CENTRAL-STATION CUSTOMERS GET TUNGSTEN-LAMP CHRISTMAS PRESENTS.

A central-station manager in a small central Illinois city pleased his customers during the holiday season by presenting to those who called at the office to pay their lighting bills 40-watt tungsten lamps. All whose November monthly bills exceeded $3 received one lamp and those whose bills were above $5 two lamps.

ELECTRIC-LIGHT PLANT ADVERTISES THE TOWN.

Citizens of Eureka, Ill., take pride in the public spirit of the Eureka Electric Service Company, which has installed on the wall of its generating station near the railroad an electrically lighted sign bearing the name of the town. As a result travelers on through trains notice this evidence of Eureka's progressiveness and remark about it when the train stops and they peer through the windows to determine their progress in the night.

BOSTON EDISON SERVICE EXTENDED IN WALPOLE, MASS.

The Edison Electric Illuminating Company of Boston has recently completed the installation of a new transformer station in the town of Walpole, which, with the rearrangement of distribution circuits in the municipality, has resulted in a marked improvement in service. The present transformer capacity of the substation is 750 kw for commercial and 106 kw for street-lighting service. A duplicate transmission line has been built for 13,800-volt service between Boston and Walpole. The capacity of the circuits in Walpole has been practically quadrupled by their rearrangement. An inefficient generating plant has been shut down at Medfield and that municipality is now supplied through Walpole. Three times as much energy as formerly can now be delivered in the districts previously served by the old Medfield station. The street-lighting circuit of the company, extending southward from Walpole through Bellingham nearly to the Rhode Island line, contains ninety miles of wire and is one of the longest circuits of its kind in the world.

ST. LOUIS UNION ELECTRIC COMPANY OCCUPIES NEW OFFICES.

On Dec. 12 the office staff of the Union Electric Light & Power Company, of St. Louis, moved from the old building at Tenth and St. Charles Streets into the company's new offices at the southwest corner of Twelfth and Locust Streets. The new building is a five-story structure faced with white tile and fronts 150 ft. on Twelfth Street and 100 ft. on Locust Street. The entire office and salesroom portion of the building is occupied by the Union Electric Company. On the first floor are the appliance showrooms, cashiers and lamp-renewal clerks. The offices of the executive department and sales department are on the second story, while the third is given over to the administrative and accounting offices. The engineers' quarters are on the fourth and fifth floors. The showrooms flank the lobby entrance to the Shubert Theater auditorium, which is in the building, affording an excellent opportunity to interest matinee and evening theater-goers in the electrical appliances of these attractively furnished rooms.

The appearance of the new Union Electric building after dark is especially prepossessing. Its shining white-tile walls loom brilliantly in the intense magnetite-arc illumination of Twelfth Street, the widest thoroughfare in the city, while every window is made a bright square of light by instructing the office employees to turn on all lamps, throw up the shades and leave the lamps to burn when they quit their work in the evening. An average power consumption of 1 watt per square foot of floor surface has been maintained in the office lighting, white walls and reflecting glassware combining to produce an illumination of 5 ft.-candles at the working plane. The brilliant appearance of this lighting from the outside will be further accentuated by outlining the building with tungsten lamps.

A RED-LIGHT POLICE-SIGNAL SYSTEM AT LOS ANGELES, CAL.

The City of Los Angeles contemplates the installation of a red-light street-signal system for the assistance of the police force in the prevention of crime. It is proposed to extend the lamps throughout the city in locations of about ten to the circuit, such circuits to be in clusters over a distributed area and not controlling a particular street. The lamps will be hung at the center of street intersections and in the vicinity of patrol boxes and will be placed from 10 ft. to 15 ft. above the regular street arcs, giving a total height from curb line of about 45 ft. to 50 ft. Red lamps at this distance cannot be mistaken and will eliminate the necessity of an officer going to the street where they might be situated. By this system the circuit cut in will show in the immediate vicinity of trouble, notifying officers working in such district. Headquarters can then communicate with patrolmen on duty instantly, whereas present conditions may cause an hour's lapse between the patrol-box calls. A similar system has recently been installed in Camden and Trenton, N. J.

BOSTON EDISON COMPANY TO ERECT LARGE ELECTRIC SIGNS.

The Edison Electric Illuminating Company of Boston has recently ordered two large electric signs which will combine moving and picturesque effects in drawing attention to the company's facilities. One sign will be located on a building in a busy section of the Back Bay and will be of the statue type, the figure being designed by Noble. The statue will represent "Progress," and the figure will be 16 ft. high, apparently set in an incandescent lamp and provided with moving-cloud effects produced by a focusing arc lamp and screens revolved by motors. The whole sign will be 26 ft. high. The second sign will be located on a manufacturing building in South Boston will be about 30 ft. long and with letters 4 ft. in height. There will be three lines of reading flashed on and then cut off, followed by a rapidly moving motor, belts, pulleys and an emery wheel. This machinery will remain visible while the figure of a man is outlined, and as a result of automatic arrangements the workman will apply an iron bar to the emery wheel and sparks will begin to fly. The "Progress" sign is being built by the American Sign Company and the industrial sign by Betts & Betts, of New York.

SEASONABLE ADVERTISING AT ST. LOUIS.

At this particular season of the year there is something refreshing and welcome in tales, events, or, in fact, anything possessing what is generally known as human interest. At Christmas the feeling of good will toward men seems to pervade the very atmosphere, while at New Year the mingled feelings half of pain and half of rapture which come to the thoughtful are lost in the happy greetings and hearty good wishes which mark the old year's knell. It is natural, therefore, that advertising which is intended to appeal to buyers should also reflect the spirit of the times. The accompanying illustration shows the advertisement inserted in the St. Louis papers by the Union Electric Light & Power Company of that city on Jan. 1. There is a subtle charm which strikes one's fancy in the reproduction picturing the winsome New Year coming in astride a tungsten lamp. Certainly the design is appropriate and the advertisement seasonable.

Attractive New Year's Greeting Printed in St. Louis Papers, Jan. 1, 1911.

RESULTS OF BYLLESBY COMPANY'S FORTY-FIVE-DAY HOUSE-WIRING CAMPAIGN.

From Oct. 1 to Nov. 15, 1910, a forty-five-day house-wiring campaign was conducted in a number of cities where central-station plants are operated by H. M. Byllesby & Company, Chicago. In general, the conduct of this campaign was similar for all the cities, with slight modifications to meet local conditions. Newspaper advertising and solicitors were both used to advantage, and the work of wiring the houses was done on a cost basis, the company paying the contractor's profit. The most successful of these local campaigns, that in Mobile, Ala., a city of 51,000 population, where 660 new customers were added to the 5000 existing consumers, was recently described in the *Electrical World*. The fifteen cities in which the forty-five day house-wiring campaign was conducted have a total population of approximately 324,000. The total number of houses wired was 1415.

LARGE CENTRAL STATIONS TO EXCHANGE ADVERTISING IDEAS.

Arrangements have been completed between the publicity departments of ten or twelve of the largest central-station companies, operating in the principal cities of the country, by which a copy of every newspaper advertisement, booklet and piece of printed matter issued by each company will be mailed to the "copy" men of all the other companies. The interchange of ideas resulting from this scheme will be especially valuable in the non-competing field of the central station, enabling each company to benefit from the new-business arguments invented and employed by its contemporaries. This arrangement for interchanging advertising matter just completed has been the subject of correspondence between several of the companies interested, dating back almost a year.

MERCHANTS GAVE POSTS; COMPANY, WIRING; AND CITY, LIGHTING.

Mendota, Ill., a little city of 4000, with 500 electric-light consumers, has installed thirty-seven tungsten-lamp pillars in its business section. The posts, which are of the curved type used at Aurora, Ill., are placed at 80-ft. intervals and each carries three 60-watt tungsten lamps. The bare pillars were paid for by the merchants, each of whom was assessed $12.50. The wiring and lamp equipment, including the setting of the posts, was furnished by the Mendota Electric Light Company, which received a ten-year contract for operating the system, the city paying for the downtown illumination as part of the general street lighting. The topmost lamps of the pillars burn all night, from dusk to dawn, and for them the company receives $2.50 per lamp per month. The lower lamps burn until midnight only, and cost $1.50 each per month. The electric company also took advantage of the street-lighting construction to put all its high-pressure lines and street mains underground in the business section.

FARM CUSTOMERS OF EUREKA (ILL.) ELECTRIC SERVICE COMPANY.

Beside its 200 lighting customers in Eureka, Ill., the Eureka Electric Service Company also supplies electrical energy to seventy-five consumers in Roanoke and fifty in Metamora, towns nine miles north of Eureka. En route the single-phase, 6600-volt, 60-cycle transmission line furnishes the means for lighting and power to about twenty farm installations. The farmers are served in little groups of three or four from a single step-down transformer at the transmission line, 110-volt or 220-volt lines being run to the farm premises. The latter pressure is used only in a few instances where an unusually long service line is required in order to reach the farmhouse. Motors to operate cream separators, grain dumpers, churns, feed cutters, etc., are run from the single-phase, 60-cycle line, and a number of electric irons are in use on these farms.

The rate to farm customers is the same as in the towns, viz., 50 cents per month service charge, plus 10 cents per kw-hour. To customers having sufficient motor load to justify a special rate 5 cents per kw-hour is charged for all energy used in addition to a primary quantity in kw-hours equivalent to twenty-five times the hp-rating of the motor. Ten per cent discount is allowed for payment within fifteen days of rendering the bill. To farm and town customers alike the company

rents or sells its motors, but furnishes its transformers for farm customers free of charge. Collections are made and meters read at three-month intervals, one trip being sufficient for both purposes. The farming element reached by the Eureka lines is of the most substantial class and collections involve no delay. The approximate date of the collector's visit is known in advance, and when he comes, reads the meter and computes the bill his money is usually awaiting him. The average income from these farm services varies from $2.50 to $4 a month. Country customers are good users of electricity. The present transmission line was built in June, 1910, when twenty-four-hour service was begun at the Eureka plant. The line passes within 100 ft. of one farmhouse where the owner has installed only recently a gas-engine-driven isolated lighting plant, furnishing service to two other farmers near by. Needless to say, this little group is pretty keenly disappointed that they did not wait for the urban conveniences on the way to reach them. The plant owner would be pleased to sell his outfit and obtain energy from the central-station lines if he could find a purchaser for his apparatus.

ELECTRICITY AT A STATE FAIR EXHIBIT.

It is significant of the increasing attention paid to electricity by those engaged in agricultural pursuits that electric lighting and electric drive played a conspicuous part in the large exhibit of the International Harvester Company of America at the recent Illinois State Fair at Springfield, Ill. The main exhibit of this large company was in a tent, and a prominent feature was an electric power plant, neatly railed off and described as the "engine-room." The accompanying illustration gives a good idea of it.

Exhibit of Electrical Apparatus.

Two 25-hp gasoline engines, made by the Harvester company, were belted to two Fort Wayne 16-kw, 125-volt, direct-current dynamos, and there was a two-panel switchboard of blue Vermont marble. All wires leading to and from the board were carried in metal conduit under the ground. The entire "engine-room" was raised 14 in. from the ground, and the floor was covered with linoleum.

The lighting load included 690 green incandescent lamps used in decoration, some of them, as wired in festoons within the tent, being shown in the picture. There was also a double-faced flashing sign representing the monogram of the company and mounted on the central pole of the tent, as shown in the picture. The power load consisted of four motors. One of these, a 5-hp machine, was belted to a line of spreaders, hay tools and a corn-picking machine. There was also a motor of the same size belted to twine-making machines used in the manufacture of the twine used in grain binders. Another 5-hp motor was belted to a line of horizontal gas engines to show the latter in motion. The engines were connected in such a way that, although of different sizes, they all revolved at the same speed, making an attractive exhibit. A 1½-hp motor was used in the cream-separator exhibit.

Electricity was also furnished to operate the company's moving-picture show in a separate tent, one large arc lamp here taking 60 amp. Electric fans were also used about the exhibit and lamps attached to long flexible cords were employed to show the inside construction of the various types of agricultural machinery.

The company also made a "power-house-on-the-farm" exhibit, which consisted of a 4-hp gas engine belted to a line shaft. From this shaft were operated a 2-kw, 30-volt generator, as well as a corn-sheller, a feed-grinder, a cream-separator, a grindstone, an emery wheel, a pump, a fan mill, a circular saw and a washing machine. A 16-cell storage battery was also included in this exhibit. The lamps used here were 20-watt tungstens, and the battery was of service in connection with the night police lighting.

As a whole the exhibit attracted much attention, and it is probable that it will be repeated, with improvements, at other State fairs to be held during the present year. Mr. B. E. Avey, of Aurora, Ill., installed the electrical features of the exhibit.

RESULTS OF ST. LOUIS HOUSE-WIRING CAMPAIGN.

Several months ago a house-wiring campaign was planned by the officials of the Union Electric Light & Power Company, St. Louis, with the threefold purpose of getting unwired, incompletely fixtured and already wired houses connected to its lines.

For prospective consumers desiring their houses wired the company arranged with several contractors to have this work done at a low price, the amount of which, if desired, was assumed and paid by the electric company, the customer reimbursing it in twelve monthly instalments. In sending solicitors out to make these contracts for house wiring it was found very advantageous to have them provided with a fixed scale of prices for the work, so that the amount could be quickly determined without the delay of having another man estimate on the job. Such delays often result in the customer's changing his mind about the amount of investment he wishes to make. The company's agreement with the contractor stipulated a maximum charge of $18 for five outlets in a five-room house, with a proportionate advance for additional lamps if desired.

Where houses were wired but had no fixtures installed the company offered six fixtures complete for $12.63, also payable in twelve instalments.

To occupants of completely equipped houses near its lines, but not connected, the company offered to loan electric lamps, inspect the house wiring and make outside connections free of charge on sixty days' trial. If the consumer proved dissatisfied at the end of this period the company agreed to take back its lamps and disconnect its service, charging only for the energy used at its regular rates. If the sixty-day trial service satisfied the customer he paid for the lamps, renewable free of charge, and contracted for the service at the usual rate.

In planning the campaign just described the first step was a house-to-house canvass by men and women agents, who reported whether the houses they visited were unwired, unfixtured or wired, whether Union Electric service was used, and if this was satisfactory. In the case of present customers of the company the agents turned their attention to demonstrating appliances and heating apparatus, selling the devices, if possible, or leaving them on trial. From the results of this canvass white, blue and buff-colored cards were filled out, indicating whether the house visited was already a consumer of electricity or, if not a consumer, was wired or unwired. To 7000 of these card addresses of non-consumers of electricity five circular letters were mailed in succession explaining the wiring-at-cost and free-connection offers. Newspaper advertisements and car posters with return-postcard tablets were also

used in the campaign to acquaint the public with the company's liberal proposals toward new consumers. Of the circular letters it was noticed that replies usually followed the third letter at least, while by the time the fifth was received the new customer was usually ready to sign a contract.

As a result of the sixty days' operation of this campaign Mr. L. F. Philo, contract agent for the Union Electric company, announces that 200 houses have been wired, seventy-five equipped with fixtures and 300 formerly unconnected wired residences secured for the company's service. The effect of the campaign has also been noticeable in increasing the average residence customer's consumption and in extending the outlying alternating-current distribution over a larger area. Following the present residence campaign the Union Electric company contemplates similar efforts among long-hour commercial users of lighting, such as drug stores, restaurants and cafés.

The St. Louis company has recently secured the services of an illuminating engineer, Mr. J. F. McGlesney, formerly of Chicago, whose expert assistance is offered without charge to those planning the lighting of rooms or buildings, including owners, architects and consulting engineers who do not make an especial study of lighting arrangements. The company's illuminating engineer co-operates with the architect or engineer, if one is employed, or will suggest to the customer interested the best means of improving his illumination or enhancing the effectiveness of the lighting.

CENTRAL-STATION RESULTS AT BROCKTON, MASS.

The return of the Edison Electric Illuminating Company of Brockton to the Massachusetts Gas and Electric Light Commission for the year ended June 30, 1910, indicates that the demand for central-station service in the Brockton district is increasing in a thoroughly satisfactory manner. The total income of the company in 1910 was $291,153, compared with $243,603 in 1909, or an increase of 19.5 per cent. The largest item of increased earnings was sales for motors, there being an income from this source in 1909 of $44,053, compared with $67,261 in 1910. The gain in motor-service earnings was nearly $2,000 per month, or 52.3 per cent over the previous year. The policy of the managers of the Brockton and Lowell companies (Lowell figures were printed in the issue of Nov. 3), Messrs. Stone & Webster, has been to institute a vigorous campaign for motor business within the past year or two, and the resulting expansion of this service has been remarkable. The total sales of the Brockton company for 1910 were 6,341,370 kw-hours and the average income per kw-hour was 4.6 cents. Of the foregoing output, which included street and commercial lighting as well as motor service and sales of electricity to other companies, 2,507,232 kw-hours were sold to motor consumers at an average return of 2.68 cents per kw-hour. A year ago the sales required the delivery of 1,247,079 kw-hours to consumers having motors and at an average return of 3.53 cents per kw-hour. The motor service development work has plainly resulted in substantial benefits to the community served, for the figures show that the average motor user pays nearly 0.9 cent less per unit this year than he did a year ago, while the company's output for motor service increased 1,260,000 kw-hours.

The commercial lighting income of the Brockton company increased in the past year from $141,680 to $154,069. The lighting rates were reduced from 20 cents to 16 2/3 cents per kw-hour and the company acquired the central-station service in the towns of Bridgewater and Stoughton, putting its prices into service in these small communities and transmitting electricity throughout the district from its turbine station at East Bridgewater. Other municipalities served by the company are Brockton, Whitman, East Bridgewater and Avon, the total population of the territory being about 85,000 at the present time. The average revenue from commercial lighting was 10 cents per kw-hour in 1909 and about 10.8 cents in the year just closed. The street-lighting income gained about $10,000 during the year, part of the increase, however, being due to the consolidation with the companies serving outlying communities.

The total connected load of the company on June 30 last was 6573 kw, the total number of customers being 2175. The connected load consisted of municipal arcs, 280 kw; municipal incandescents, 52 kw; commercial arcs, 557 kw; commercial incandescents, including miscellaneous company lamps, 3171 kw; commercial motors, 2513 kw. The average income from motor service per kilowatt of connected motor load was $26.70, or $19.80 per horse-power per year.

The company generated 8,079,038 kw-hours during the year and purchased no energy from outside sources. The major part of this output was delivered by the turbine station at East Bridgewater, which contains a steam generating plant of four 525-hp Babcock & Wilcox boilers and two 1500-kw vertical Curtis turbo-alternators operating at 900 r.p.m. and delivering energy to the outgoing lines at 13,200 volts, three-phase connections. The old steam plant of the company in Brockton is used mainly as a substation, although upward of 2000 hp in steam equipment is held in reserve here in case of trouble at the turbine plant. The manufacturing cost at the station alone, figured for the entire output of the company, and not taking into account capitalization charges or any distribution, management, taxation or miscellaneous expenses, was $71,766 for the past year, the principal items being:

Fuel	$45,438
Oil and waste	669
Water	451
Wages at station	18,436
Station repairs	1,747
Steam equipment repairs	2,252
Electric equipment repairs	600
Miscellaneous tools	2,173
Net manufacturing cost	$71,766
(or 0.89 cent per kw-hour manufactured.)	

The principal items of operating expense for the year were: Manufacturing cost, $71,766; distribution, $39,675; office expenses and management, $39,098, and taxes and miscellaneous expenses which brought the total expenditure to $175,814, or 2.87 cents per kw-hour sold. The company declared dividends of $61,208, or about 0.97 cent per kw-hour sold, leaving a margin of about 0.75 cent per kw-hour from the total receipts to meet interest, depreciation and contingent charges. These figures show conclusively that while the station cost of electrical production is of much technical interest, there is only a small margin left after legitimate expenditures or apportionments are made for the requirements of the surplus. The "man in the street," seeing from the return to the State that the company

CENTRAL-STATION FACTS AND FACTORS, BROCKTON, MASS., 1910.

Kw-hours delivered at station busbars	8,079,038
Kw-hours sold, total	6,341,370
Percentage of output sold	78.5
Kw-hours sold for electric motor service	2,507,232
Total income from operation	$291,153
Total income from electric lighting (commercial service)	$154,069
Total income from electric motor service	$67,261
Total investment in physical plant	$1,253,390
Kw rating of station equipment owned by company	5,061
Number commercial lighting customers	1,853
Estimated population of company's territory, 1910 (Brockton, 1910 census, 56,878, other towns, 1905 census, 24,304)	85,000
Total connected load in kilowatts	6,573
Average total earnings per kw-hour sold, cents	4.6
Average total earnings from motor-service sales, cents	2.68
Total cost of plant per kilowatt of station rating	$248
Gross yearly income per kilowatt of station equipment	$57.50
Gross yearly income per capita of population, approximately	$3.40
Ratio of connected load to station capacity	1.3 to 1
Yearly load factor (average divided by maximum of 2750 kw)	33.3 %
Watts station rating per capita	59.5
Number of consumers per capita	0.0256
Average income per kilowatt of motor load per year	$26.70
Average income per consumer	$134
Gross liabilities (capital, bonds, loans)	$1,232,800
Cost of plant more than capital and loans	$111,777
Total liabilities per kilowatt of station rating	$244
Investment per capita	$14.75
Number consumers per hundred population	2.5
Number of consumers	2,175

can produce electricity at its station for something under 1 cent per kw-hour with coal at $4.27 per ton, may well note that the actual cost of delivering a kw-hour to the customer is in this instance easily from three to four times the mere station cost, which does not take into account the necessary provision to keep the plant and system up to modern standards of practice, insurance, office expenses, the cost of transmitting and delivering energy over a wide area, administration, legal charges and the necessary bond interest, all of which must be met before a cent of dividends can be declared. In order to produce electricity for general uses in its territory the company maintains a plant and system representing an investment of $1,253,390, or $184 per horse-power of steam-generating capacity at the dynamo shaft. The principal items of the investment are: Steam plant, $276,921; land and buildings, $257,601; overhead lines, $251,224; electric plant, $211,171, and underground lines, $146,812.

Various data of the year's operation are summarized in the table on the preceding page.

Wiring and Illumination

BAD PRACTICE IN ELECTRICAL WORK.

By T. W. Poppe.

A bad practice that is daily growing, due no doubt to the keen competition in the electrical trade, is the manner of setting outlet and switchboxes in wooden paneling and wainscoting. Fig. 1 shows a questionable method of setting an

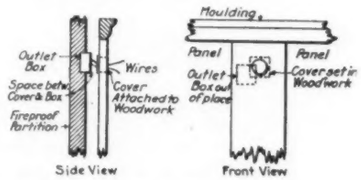


Fig. 1—Wrong Method of Installing Outlet Box in Wainscoting.

outlet box in wooden paneling or wainscoting. This method is employed in many rush jobs when the cry is "Get the work done" and the demand is for a speedy finish.

To gain speed in placing the boxes in position, the wireman, with the sanction of the man in charge of the work and often at his command, places the outlet box at the approximate point and places a small quantity of plaster of paris or cement around it to hold it in position. The mechanic whose duty it is to secure the panels in position cuts the proper size of hole, at the proper point, in the wooden paneling, removes the cover from the iron outlet box and fastens it to the rear of the wooden paneling. This causes the outlet

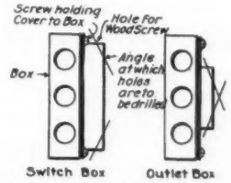


Fig. 2—Methods of Fastening Outer Box.

to come in the exact position, but it leaves a bad condition when the paneling is permanently fastened in position. There is often a space large enough to allow any flame which might be caused by a short-circuit or ground in the outlet box to escape to the woodwork, which is usually well seasoned and dry and susceptible to the intense heat generated by a short-circuit or ground. Fig. 1 shows a box and cover placed in position as described.

To overcome this condition, meet the demands of the keen competition in the electrical trade and make a thoroughly fireproof job is a comparatively easy matter. Fig. 2 shows an outlet box changed slightly to meet the exigencies of the case. In wooden panels it is absolutely necessary that the outlet be in the exact position, as any deviation will break the symmetry of the paneling. The box as shown in Fig. 2 can be fastened, by means of the cover, directly to the panel, and as the cover is fastened to the box there will be no space to

Figs. 3 and 4—Fixture Stud and Support.

allow any flame to escape to the woodwork in the event of a short-circuit or ground.

In Fig. 2, where thus marked, the holes are drilled in the cover diagonally so as to allow a wood screw being passed through the hole and into the wood. This will hold the cover securely in position, and the box being fastened to the cover will also be held securely. To provide for fixture support a stud (Fig. 4) is fastened to the box by using two pieces of band iron, ⅛ in. x ½ in., bent as shown in Fig. 3. The two pieces of band iron are placed at right angles to each other and the fixture stud fastened to them by means of stove bolts. The band iron and fixture stud now form practically one piece, which is then placed in position as shown

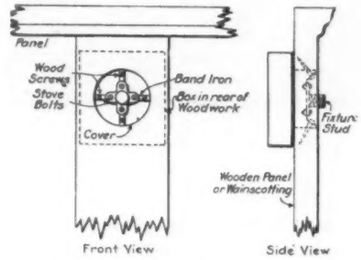


Fig. 5—Fixture Stud in Place.

in Fig. 5 and fastened to the cover of the outlet box, using the same wood screws which hold the cover to the panel.

Should rigid conduit be used in running to the outlet, some difficulty would be experienced in getting the conduit exact This is a condition which can be easily overcome. Install the rigid conduit to within 1 ft. or so of the outlet, and when the carpenters are ready to install the paneling run from the rigid conduit to the outlet box with flexible conduit, using a combination coupling (Fig. 6) to connect the flexible conduit to the rigid conduit. The flexible conduit can be pushed from side to side or raised or lowered as the case might require.

In a building of any size these changes could be made with very little expense at any machine shop and the time saved would more than recompense a person for the little extra

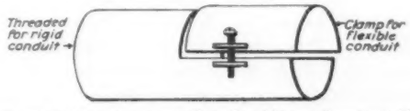


Fig. 6—Combination Coupling for Mixed Conduit Work.

trouble and cost. One saving would be in not fastening the box to the wall with plaster of paris or cement. This consumes much time, as the plaster or cement must be prepared and in fastening the cover to the woodwork as described only four wood screws are required. These a mechanic can carry in his pocket and have ready at any time.

EXTERIOR ILLUMINATION OF NEW YORK DEPARTMENT STORE.

The Gimbel store, at Broadway and Thirty-third Street, New York, the interior illumination of which was described in these columns at the time the store was opened to the public in September, during the past month was outlined with incandescent lamps for the holiday season. The accompanying illustration shows the brilliant appearance of the store

Night View of Store Illumination.

at night. The decorative scheme consists in outlining the 216 windows with 4-cp lamps, and the erection of the circuits required the services of seventeen men who worked overtime to complete the task in less than a week. The building faces Greeley Square and adjoins Herald Square, so that the illumination is very noticeable and striking. The entire electrical equipment of this store is supplied with energy from the mains of the New York Edison Company.

THE USE OF CONSTANTS IN WIRING CALCULATIONS.

By Edwin C. Ashe.

Wiring and, for that matter, many other calculations that involve the use of several constants can be much simplified by resolving the constants into a factor which is itself a constant. It frequently occurs in industrial-plant and central-station work that, for wiring computations, the permissible voltage drop and the power-factor remain the same. These and other constants can be effectively incorporated into a multiplier. An example or two will best explain the method.

Consider the problem suggested in Fig. 1. A three-phase, 220-volt, 60-cycle, 20-hp motor is to be installed at a distance of 200 ft. from the supply mains. It is assumed that the power-factor is 70 per cent and that the permissible voltage drop in the branch circuit to the motor is 6 volts. What size wire should be used? The formula for determining the size of wire in circular mils for a three-phase circuit is:

$$\text{Circ. mil} = 11 \times d \times I \div e. \qquad (1)$$

where 11 is a constant, d is the single distance in feet from the source of supply to the energy-consuming device, I is the current in amperes and e is the permissible voltage drop. All of the quantities in this equation are known except the current. It is, therefore, necessary to determine the current before the equation can be used. It should be noted that the equation gives an approximate result in that the constant 11 is not absolutely exact and that neither the inductance nor the capacity of the circuit is considered. It is, however, sufficiently accurate for estimating for short lines, and the error that it introduces is usually more than compensated for by the fact that

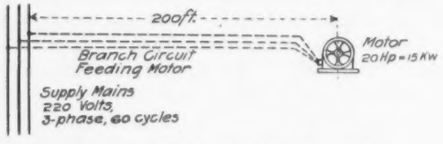


Fig. 1—A Motor-Wiring Example.

in practical work a wire of a commercial size must be used. The difference in area between any two succeeding commercial wire sizes generally more than offsets the error in the equation.

The formula below gives the current in each of the wires of a balanced three-phase circuit.

$$I = W \div (1.73 \cos \Theta) \qquad (2)$$

where I is the current in amperes, W is the power transmitted in watts, 1.73 is a constant, E is the voltage of the supply circuit and cos Θ is the power-factor of the circuit. For wiring calculations it may be assumed that the factors 1.73, E and cos Θ are always of the same value in an industrial plant where many motors are installed. These three factors can, therefore, be resolved into a constant thus:

$$I = W \div (1.73 \times 220 \times 0.7) = 3.75 \qquad (3)$$

or approximately:

$$I = 3.8 \text{ kw} \qquad (4)$$

It is apparent, then, that by multiplying the kilowatt capacity of the motor by the factor 3.8 the approximate full-load current in amperes flowing to the motor will result. The current for the motor of Fig. 1 will be $3.8 \times 15 = 57$ amp. It should be noted that the size of the branch wire to the motor required so that the voltage drop in them will not exceed a certain limit (6 volts is to be allowed in the example under consideration) can be determined directly as hereinafter explained. But it is necessary always to know the current that will flow in given leads so that conductors can be selected that are sufficiently large to carry this current without overheating. A conductor may be of sufficient area to convey energy to a device with a given voltage drop, but yet not large enough to do so without heating excessively. Therefore, after a conductor size has been determined with reference to drop it should always be checked to see that it is large enough safely to carry the current.

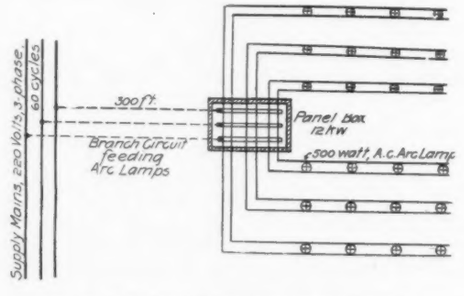


Fig. 2—An Arc-Lighting Wiring Example.

The value for current from equation (3) and the allowable

voltage drops, 6 colts, can now be substituted in equation (1):

$$CM = \frac{11 \times d \times 3.75 \text{ kw}}{6} = \text{kw } d \times \frac{11 \times 3.75}{6} = 6.87 \text{ kw } d \quad (5)$$

or approximately

$$CM = 6.9 \text{ kw } d \quad (6)$$

The conductor area should be (on the voltage-drop basis) at least $6.9 \times 15 \times 200 = 20{,}700$ circ. mil. Referring to a wire table it will be found that the next largest commercial wire size is No. 6, which has an area of 26,250 circ. mil. It will safely carry, with rubber insulation, 46 amp. But the motor of Fig. 1 takes 57 amp, so No. 4 wire, which will carry 65 amp, is the smallest that can be used.

Consider another example, involving a multiple arc-lighting installation, outlined in Fig. 2. It is assumed that the permissible drop in the branch to the panel box, the supply voltage and the power-factor remain the same as for the problem solved above. What size wire should be used for the branch conductors? Each arc lamp requires 500 watts (assumed) and as there are twenty-four arc lamps feeding from the panel box the total load is $24 \times 500 = 12{,}000$ watts, or 12 kw. The branch circuit to the panel box is three-phase, but the arc lamps are connected on single-phase circuits which are so arranged that the three-phase load is a balanced one.

The size of branch conductors which will provide a 6-volt drop with the above-outlined assumptions is from equation (6):

$$\text{Circ. mil} = 6.9 \times 12 \times 300 \text{ X } 24{,}840.$$

The full-load current will be, from equation (4): $I = 3.8 \times 12 = 45.6$ amp.

The conductor that most nearly corresponds to an area of 24,840 circ. mil is No. 6, which has an area of 26,250 circ. mil, and it safely carries with rubber insulation 46 amp. It is, therefore, large enough to convey the full-load current of 45.6 amp to the arc lamps and, therefore, No. 6 wire should be used.

From the examples it is evident that many of the wiring calculations necessary in central-station and industrial-plant practice can be made by using two constants which can be readily remembered. It may be desirable in some instances to use multipliers which will give current and conductor size values when the multipliers are multiplied into capacities expressed in horse-power instead of in kilowatts. But, as a rule, it is believed that the expressions involving kilowatt capacities will be found most convenient.

LETTERS TO THE EDITOR.

Municipal Plants and Rate Systems.

To the Editor of Electrical World:

SIR:—I have been reading with interest some recent articles bearing on rates governing the sale of electricity. Writing from a Western State where utility commissions are not common and where most of the plants are municipal property, the rate problem comes up with some new features, and I wish to make plain at this point that, while the chief object to be attained by using the revenues of the public tax to build lighting plants is to assure cheap and satisfactory service, this has been accomplished only in part. Rates for lighting purposes have been established and the average resident subscriber can buy electricity for 10 cents per kw-hour, with a minimum charge of 50 cents per month. With this common rate in effect municipal plants with capacities ranging from 75 kw to 500 kw have in service from 150 to 1500 meters. As the service is practically all lighting, the natural result is a very high peak load to which the municipal board usually points with considerable pride and hastens to explain that this patronage was procured chiefly by maintaining continuous service and a fair rate. And here is the straw that breaks the camel's back: Appended to this "fair rate." and treated by most boards as a necessary evil, is a motor rate of 6 cents per kw-hour, with 5 cents or possibly 4 cents offered as an inducement to some subscriber to use 50 hp—an exact reversal of the so-called "discriminating rate" extended to the large consumer by privately owned plants. A liberal application of the formulas that govern engineering practice will prove to any one concerned that when a company can for 10 cents per kw-hour deliver energy to a service that constitutes a part of its peak load only it can furnish energy to a service operating in daylight hours at a rate of 2 cents per kw-hour with equal profit. With this rate in force the writer is firm in the belief that the municipal board will find the load-curve running high in the daytime, and the necessity for a tax levy to liquidate the bonded indebtedness caused by the old rates entirely abolished.

Wamego, Kan. D. A. COURSE.

Line Poles Destroyed by Birds.

To the Editor of Electrical World:

SIR:—On the Sonora line of the Ferrocarril Sud-Pacifico de Mexico, running between Nogales and Guaymas, Sonora, we are greatly troubled from damage to telegraph poles by woodpeckers. These birds are most numerous between Hermosillo and Magdalena, a distance of 200 km. They make no distinction as to the class of wood, all being alike to them. In my office I have a sample of creosoted pole which has been in use for a little over two years, and which has a hole 5 in. high x 2½ in. wide; inside this opening there is a hole dug out something like 18 in. deep x 5 in. wide. The portion of the pole taken out is 7 in. in diameter and shows that the pole had been well treated with creosote. Some of our cedar poles have from four to five deep holes in them, and redwood about the same. We have taken out 250 of the bird-eaten poles and have about 200 more to remove. The kind we are substituting is a smaller pole burnettized, with a creosoted butt. These have not yet been touched, although we began rebuilding last March, stopping work during the rainy season. I should greatly appreciate any information from your readers as to the best method, aside from a shotgun, to get rid of these pests, as poles cost considerable money in this section of Mexico.

C. T. DAY,
Assistant Superintendent of Telegraph, Ferrocarril de Sonora.
Empalme, Sonora, Mexico.

Converter Substations.

To the Editor of Electrical World:

SIR:—The writer has just returned from a business trip to Europe and has read with interest the letter of Mr. A. R. Miller in your first issue of November, which came out just after the writer sailed.

Mr. Miller is correct in his statement that the substation design, shown in Fig. 1 of the writer's article, that appeared in your first issue of August resembles in many respects the arrangement of the stations of the Brooklyn Rapid Transit Company. This was stated in the writer's letter, which was published in your first issue of October, but the stations differ in the respects mentioned in that letter.

Mr. Miller is also correct in his statement that the engineers of the Boston Elevated Railway Company, as well as the writer, had visited the substations of the Brooklyn Rapid Transit Company. The writer, moreover, has also visited the converter substations in New York, Philadelphia, Baltimore, Washington, Buffalo, St. Louis, Louisville, Chicago, etc., and has naturally been influenced by all such visits.

Practically no converter substation of recent design fails to embody many ideas that have been of value in previous designs, and an engineer would be rather short-sighted who failed to utilize the results of others' experience and his own observations.

The writer does not see how his letter in your first issue of October could be construed as claiming originality for all or

any of the features of particular merit in the arrangement of the substation in question, but it was spoken of as a suggested arrangement that embodied the ideas of the engineers of the Boston Elevated Railway Company as well as his own.

The writer does not wish to detract in any way from the credit due to Mr. Miller and his associates for the very satisfactory manner in which they have designed the converter substations of the B. R. T., but practically every point mentioned by Mr. Miller as having been copied from the designs of the B. R. T. was really taken from designs considerably antedating the stations of the B. R. T.

The relative location of circuit-breakers, air-blast transformers, rotaries and switchboard used by the B. R. T. is practically the same as was installed in Baltimore, Louisville, St. Louis and other cities eight or ten years ago, and it is the logical arrangement that would naturally suggest itself to any one familiar with the apparatus. Manufacturers' publications as well as articles in technical journals have shown this general arrangement for years.

Relative to the arrangement of the wiring passing from underground cables through disconnecting switches and breakers to a bus above the breaker, this scheme is shown in Fig. 2 of the writer's article which illustrated the station of the Union Electric Light & Power Company, of St. Louis, installed about eight years ago. This sketch also shows feeder knife selector switches mounted above and pulled from in front of the feeder breakers and connecting to either of two duplicate sets of busbars on a gallery above the breakers.

The locating of a pedestal with the negative and equalizer switch on it near the rotary as well as the running of the negative and equalizer buses between the pedestals has been standard practice with direct-current railway generators for years.

In a similar manner each individual point of design mentioned in Mr. Miller's letter can be traced back to what might be called "ancient history," and it would be an extremely difficult matter to determine who was the originator and who was entitled to the credit for the arrangement.

Pittsburgh, Pa. STEPHEN Q. HAYES.

Digest of Current Electrical Literature

ABSTRACTS OF THE IMPORTANT ARTICLES APPEARING IN THE ELECTRICAL PERIODICAL PRESS OF THE WORLD

Generators, Motors and Transformers.

Voltage Between Segments in Direct-Current Machines.—T. HOOCK.—When a direct-current machine is loaded the flux produced by the armature distorts the primary flux. The flux density at one rim of the pole is increased and the voltage difference between adjoining segments is correspondingly increased. In motors built for wide variations of load by means of field adjustment the high voltage between segments may cause an arc. Various numerical examples are given.—*Elek. Zeit.*, Dec. 15.

Changing the Number of Poles.—F. NIETHAMMER AND E. SIEGEL.—To change the speed of three-phase induction motors the frequency of the network may be varied. Such a change of the frequency can be easily obtained by changing the number of poles of the generator. The authors describe a new method of the Austrian-Siemens-Schuckert Company, in which only the field system is changed from four poles to two poles, while no change is made in the armature. Tests were made with such a generator driving an induction motor, which was found to operate to perfect satisfaction at 1200 r.p.m. with a four-pole arrangement of the generator and at 600 r.p.m. with the two-pole arrangement. Some details are given of an oscillographic study made in connection with these tests.—*Elek. u. Masch.* (Vienna), Dec. 4.

Circular Diagram of Induction Motor.—K. KRUG.—The author shows that Ossanna's exact circular diagram for the polyphase induction motor can be derived in a comparatively simple manner by the analytical method with the aid of the symbolic notation.—*Elek. u. Masch.* (Vienna), Dec. 4.

Commutator Motors for Three-Phase Currents.—A. SCHERBIUS.—The first part of an article on the design of commutator motors for three-phase circuits especially for use with reversing rolling mills and winding in mines. In the present instalment the author deals especially with the Deri system of brush displacement for regulation of the motor and discusses the advantages of this method over the use of an ordinary repulsion motor.—*Elek. u. Masch. Betriebe*, Nov. 25.

Induction Motors.—J. FISCHER-HINNEN.—A fully illustrated English translation of his German paper, recently abstracted in the Digest, on recent developments in induction-motor design, with special reference to arrangements of the starting resistance inside the motor itself.—Lond. *Elec. Review*, Dec. 16.

Eddy Currents.—A mathematical article on the eddy currents in solid conductors of rectangular cross-section embedded in rectangular slots, giving formulas for the current density, etc. —*Elek. u. Masch.* (Vienna), Nov. 13.

Lamps and Lighting.

Public Lighting in London.—A historical sketch of the development of public lighting in the City of London. It was not until about 1903, when the magazine lamp became a commercial success, that it was found feasible to advocate any material change in the open-type arc lamps, which had so far proved satisfactory for the public lighting of the city. In 1904 and 1905 flame-arc lamps were introduced. Then came the various experimental trials with high-pressure gas in several streets, but electric lighting came to the front again in 1908 and 1909. A description is given of the central-suspension system used in the Cheapside and Watling Street areas. The chief merit of this system lies in the advantageous position relative to cross streets in which it enables lamps of high candle-power to be placed at any desired height above the roadway. A 12.5-amp magazine flame lamp is used, its special feature being the Peard prismatic reflector. These reflectors consist

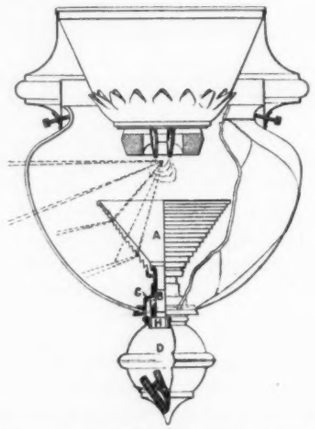
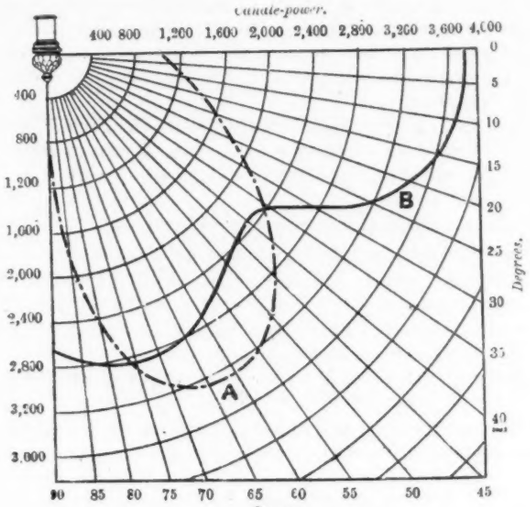


Fig. 1—Oriflamme Arc-Lamp Globe with Peard Prismatic Reflector.

of funnel-shaped glass dishes *A* (Fig. 1) screwed to a movable tabular stem *B* supported by a special fitting *C* attached to the bottom of the outer globe, which is of clear glass. Their function is to increase the candle-power of the lamps near the horizontal plane, thereby greatly adding to their effective power for street-lighting purposes; they also enlarge the visible area of the light source and screen the eye from the direct rays of the arc at all angles greater than 35 deg. below the horizontal. In

addition they serve a very useful purpose in materially reducing the deposit on the globes, all carbon ends and dust passing through the reflectors into a detachable copper-ball fitting *D* below the globes. By the use of these reflectors and fittings an effective candle-power is obtained of 3500 at and somewhat below the horizontal plane, while the mean hemispherical candle-power is maintained above 2800 candles. The polar candle-



A = With ordinary light opalescent outer globe.
B = With clear outer globe and a "Peard" Prismatic reflector.

Fig. 2—Polar Curves of 12.5-Amp Oriflamme Lamp.

power curves of the lamp are shown in Fig. 2, in which *A* refers to the use of an ordinary light opalescent globe and *B* to a clear outer globe with a Peard prismatic reflector. Notes are then given on central lighting by high standards on Farrington Street. The 12.5-amp Excello flame-arc lamp is used, the lamps being fitted with inner dioptric, deposit-free globes

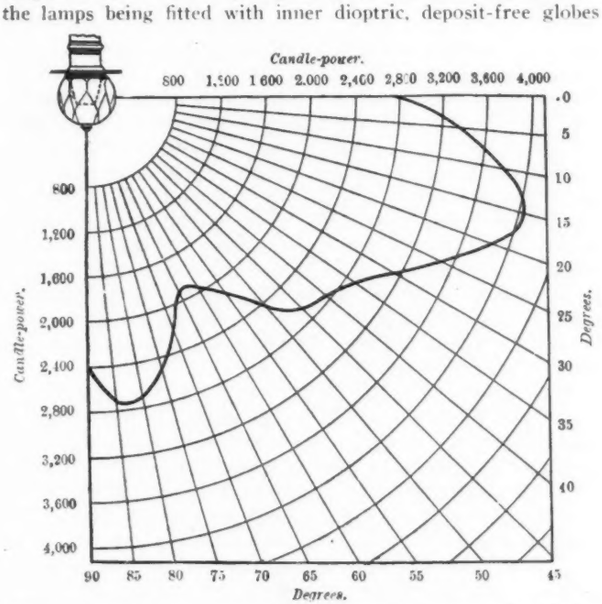


Fig. 3—Polar Curve of 12½-Amp Excello Arcs with Dioptric Inner and Semi-Opalescent Spherical Outer Globes.

within very slightly opalescent spherical outer globes. The polar candle-power curve is given in Fig. 3. The article is to be concluded.—Lond. *Electrician*, Dec. 16.

Filter for Ultra-Violet Rays.—H. LEHMANN.—A paper on an absorption filter for the production of pure ultra-violet rays from rays given out by the usual source of light. He employs nitrous dimethylanilin. This may be used as an aqueous solution or as a solid solution in gelatine. However, this material still permits green and red rays to pass. He, therefore, combines this material with Jena "blue uviol" glass, but even thus some red rays are still permitted to pass. To cut them out he employs a 20 per cent copper sulphate solution in water. For the whole combination he uses a vessel the walls of which are made of blue-uviol glass plates filled with copper sulphate solution, while one of the outer surfaces of the glass plates is covered with a solution of nitrous dimethylanilin in gelatine. This combination is absolutely non-transparent for sources of light with few ultra-violet rays, like ordinary incandescent lamps. But it permits the passage of ultra-violet rays to a greater degree than any other filter combination. It is especially useful for the study of photoluminescence. For demonstrating purposes, for instance, the ultra-violet rays coming from the filter may be projected on a linen cloth or paper, when a blue-white spot of light will appear. That this light is of secondary nature is proved by the fact that a white, dull porcelain plate substituted for the linen cloth or paper appears perfectly black. Porcelain is one of the few substances which show almost no fluorescence. The method may be used for testing the chemical purity of substances, the genuineness of gems, etc., as well as for physiological experiments.—*Phys. Zeit.*, Nov. 15.

Three-Phase Arcs.—L. CROUCH.—An illustrated description of the Mercanton-Righi three-phase arc lamp with four electrodes, three lower electrodes connected to the three phases being opposite to a larger upper electrode which is not connected to the circuit. There are six craters. The consumption of the fourth upper insulated electrode is very low. It is believed that these arcs are steady and satisfactory on traction circuits of 15 cycles per second.—Lond. *Elec. Review*, Dec. 9.

Arc Lamps.—In continuations of a long illustrated serial brief descriptions are given of various new magazine lamps in which when one pair of electrodes is finished another pair is put into operation automatically. The descriptions are mainly based on recent German patent specifications.—*Zeit. f. Beleucht.*, Nov. 20 and 30.

Vacuum-Tube Lighting.—D. McF. MOORE.—A lecture giving a historical sketch of the development of the nitrogen and carbon-dioxide vacuum-tube lamps.—*Jour. Franklin Inst.*, November.

Generation, Transmission and Distribution.

Combined Destructor and Electricty Works.—E. K. SCOTT.—The author points out that after the early exaggerated claims and unjustified criticisms the combined refuse destructor and central station is now proving its value. It is pointed out that some of the lowest fuel costs for electricity works are obtained where steam from refuse destructors is used, as, for example, at Hackney (the lowest in London), St. Helens and Partick. The number of kw-hours per ton over a whole year's working varies, of course, with different plants; fifty seems an average figure which any moderately well-managed combined plant might attain to, and ninety-seven has been reached on an eight-hour test. The author gives directions as to the site of the plant, quality of refuse, charging dust, arrangement of the building, exit of the gases, the heated-air supply, thermal storage, clinker and its uses, etc. To make a success of the combined station the refuse destructor should be in charge of the electrical engineer. By combining the two, one office and staff is sufficient. As hand stoking is absolutely necessary and good management of the fire and draft makes all the difference between success and partial failure, the stokers should be picked men and the number of them sufficient so that they are never pressed to get through their work.—Lond. *Elec. Review*, Dec. 9.

Electric Supply in England.—Statistical tables of 119 electric supply companies in Great Britain, giving details of equipment, rates, etc.—Supplement to Lond. *Electrician*, Dec. 16.

Traction.

Vienna.—J. SEIDENER.—A report made to the Vienna Electrical Society pointing out the necessity of introducing electrical operation on the Vienna Stadtbahn, especially for the purpose of running trains at shorter intervals and removing the smoke nuisance and thus bringing the road into greater general favor. An account of the discussion which followed is also given—*Elek. u. Masch.* (Vienna), Dec. 11.

Electric Steering Gear for Ships.—K. Trowbridge.—The author gives brief illustrated sketches of the systems of the Union Elec. Ges., Pfatischer and Brown & Haigh. Direct-current compound-wound motors are most suitable. A comparatively large number of vessels have electrically controlled steam steering gear; a much smaller number have complete and independent but interchangeable electrical and steam steering gear, while a very few ships have purely electrical steering equipment.—Lond. *Elec. Review,* Dec. 16.

Rail Corrugation.—A. Busse.—His report to the International Congress in Brussels on the causes of rail corrugation. He concludes that the ultimate cause must be found in the steel itself.—*La Lumière Elec.,* Dec. 10.

Installations, Systems and Appliances.

Storage Battery Engineering.—J. Appleton.—A Franklin Institute paper in which the author first discusses the use of the storage battery for emergency or stand-by service in substations and to carry peaks of short duration due to accidents on transmission lines caused by excavations, building operations, etc. For such purposes the requirements are maximum output of energy for short periods; maximum first cost and upkeep; minimum space requirements and weight. These batteries need have a life of only about 300 discharges, as the estimated number of discharges per year in this service would not exceed twenty or thirty. The author gives data on a storage battery designed especially for this purpose in comparison with other batteries. A battery installed in the Sixteenth Street substation of the New York Edison Company consists of 150 cells, each containing 131 plates. The output at various rates is 10,790 amp for one hour, 21,580 amp for twenty-one minutes, 32,370 amp for ten minutes and 43,160 amp for six minutes. In connection with this problem importance is placed on the design of end-cell switches which can carry such enormous currents and enable additional cells to be cut in during the discharge as the voltage of the cells drops. The author gives the following figures for the percentage of battery rating (figured on the one-hour discharge rate) to the maximum direct-current peak loads of the following companies: New York Edison, 25 per cent; Chicago Edison, 48 per cent; Brooklyn Edison, 36 per cent; Boston Edison, 36 per cent. The author then briefly discusses the use of storage batteries in connection with purchased-energy contracts and the regulation by storage batteries of alternating-current generating plants. The storage-battery plant of the United States Steel Corporation at Gary is described in some detail. In connection with the regulation of fluctuating loads by means of storage batteries the author mentions a device to enable the storage battery equipment to take the quick fluctuations, relieving the generating machinery of them entirely, but throwing slowly into the generators fluctuations which are sustained for any length of time. For this purpose an automatic device has been developed for changing the average load on the generators with sustained changes in the demand. The device consists of a small motor actuating the booster regulator through reducing gear. The principle of its action is that on a discharge of the battery the motor is operated so that it revolves in a direction slowly to raise the load on the generators. On a charge of the battery the motor runs in the opposite direction, thus slowly relieving the generators of load. A battery equipped with the average adjuster will still take the rapid fluctuations, but will not hold the generators to a fixed average, the sustained changes being gradually transferred from the battery to the machines. To hold the generator load line below a fixed limit a simple stop has been designed to open the adjuster circuit when the generator load reaches a predetermined point. The generators can thus be made to work up to any desired limit, the battery taking all the quick fluctuations and also the sustained peaks above the limit.—*Jour. Franklin Inst.,* November.

Wires, Wiring and Conduits.

High-Tension Cables.—P. Humann.—In cable manufacture it is often the practice to use the same insulation thickness for cables with different copper thicknesses or even to increase the insulation thickness with increasing thickness of the copper conductor. This practice is wrong. To get the same degree of safety the insulation thickness should decrease with increasing copper diameter. This is illustrated in diagrams. If the voltage of operation E has a certain given value, and if the potential gradient e in the insulation layer next to the copper (where the potential gradient in the insulation is a maximum) has also a certain value, the radius of the copper conductor can be so chosen that the cable diameter becomes a minimum. For this purpose the radius must be made $= E \div e$ for single cables and $= \frac{2}{3} E \div e$ for three-phase cables.—*Elek. Zeit.,* Dec. 15.

High-Tension Insulators.—Kuhlmann.—A French translation of his recent German paper giving a critical illustrated review of modern high-tension insulators.—*L'Industrie Elec.,* Dec. 10.

Electrophysics and Magnetism.

Electric Stress at which Ionization Begins in Air.—A. Russell.—An abstract of a London Physical Society paper. In the "Proceedings" of the American Institute of Electrical Engineers for July, 1910, J. B. Whitehead publishes the values of the electric stress at which ionization begins in air. The electrodes he used in his experiments consisted of a metallic tube and a cylindrical wire coaxial with it. Alternating pressures were employed, and the inner wires used had diameters varying in size from 0.089 cm to 0.475 cm. If A be the radius of the inner wire the author has found that the expression $32 + 13.4 \sqrt{A}$ gives all Whitehead's experimental results for the maximum electric stress in kilovolts per centimeter with a maximum inaccuracy of less than 1 per cent. The experiments show that the electric stress at which ionization occurs is independent of the metals used for the electrodes and of the inner radius of the outer tube. It depends merely on the radius of the inner wire. It is shown that Steinmetz's experimental results on the sparking distances between parallel rods are in substantial agreement with Whitehead's figures. An empirical formula is given which is based on experimental results recently published by Kowalski and Rappel for the sparking voltages between equal spherical electrodes. The results indicate that the electric stress at the moment of discharge has a minimum value when the distance between the electrodes is a certain function of their radius. The author lays great stress on the currents of electrified air which stream around the electrodes before the discharge takes place and the effects of which it is customary to neglect. These currents often modify very appreciably the values obtained for the disruptive stress at the moment of discharge. There is a striking similarity between the formula for the temperature gradient at the surface of a hot wire cooling in air and the empirical formula for the potential gradient at the surface of an electrified wire when ionization is taking place at its surface.—Lond. *Electrician,* Dec. 16.

After-glow of Electric Discharge.—R. J. Strutt.—An abstract of a London Physical Society paper. It has long been known that when an electric discharge has passed at low pressure through certain gaseous mixtures a luminosity survives for some seconds after the discharge has been turned off. A greatly improved method of experimenting on the phenomenon was introduced by Dewar. A powerful air pump is used to draw a regulated current of gas through the vacuum tube. In this way a continuous removal of the gas from the region of discharge is effected, and the after-glow which it emits in passing through another vessel on its way to the pump can be examined continuously and at leisure. There has been considerable difference of opinion as to whether pure oxygen shows a glow or not. Under the conditions of the author's experiments the glow, if any, is certainly exceedingly faint. With air, on the other hand, a bright yellow glow is obtained, which is improved by enriching the air with oxygen. Pure nitrogen gives no glow whatever. Several previous experimenters have connected the glow with ozone, though generally without expressing any very definite view as to what part ozone played in its production. The chief evidence for

this hitherto has been that the glow is obtained only where oxygen is present and that it is destroyed by heat. The following additional evidence was obtained: (1) The glow cannot survive passage through a tube cooled in liquid air. This is regarded as due to condensation of ozone. (2) It is destroyed by passage over oxides of copper, manganese and silver. Ozone, too, is known to be destroyed by these substances. (3) While the glowing gas oxidizes bright silver, the gas current beyond the point at which the glow has died out does not do so. Disappearance of the glow is simultaneous with disappearance of ozone from the gas. The glow is thus shown to involve consumption of ozone. It is, therefore, natural to regard it as a flame of low temperature, arising from the oxidation of some other body of ozone. The next experiments were made to determine the nature of this other body. A current of ozone from a vacuum tube fed with oxygen was allowed to mix, in a Y-shaped tube, with any other gas which it was desired to test on its way to the pump. Nitrogen or ordinary air added to the ozone gave no effect, but air which had been through an independent discharge, and had been deprived of its original glow by silver oxide, was found to glow again on mixing with ozone. Clearly, then, some body is produced in air by the discharge whose oxidation is responsible for the glow. This body proves to be nitric oxide. On leading a current of this gas into the ozone stream a very brilliant glow was obtained, of the characteristic yellow color. By suitable arrangements this glow can be produced in the form of a pointed flame with dark inner cone. The glow is not associated with a sensible rise of temperature. Condensing the ozone with liquid air, allowing it to re-evaporate and admitting nitric oxide to it, a yellow flash can be obtained long after the electric discharge is over. The glow is purely chemical in its origin. The main conclusion of the present paper is that the ordinary yellow after-glow is due to oxidation of nitric oxide by ozone.—Lond. *Electrician*, Dec. 16.

Magnetic Properties of Iron Alloys.—An account of the extended discussion which followed the paper of Hadfield and Hopkinson recently abstracted in the Digest.—Lond. *Electrician*, Dec. 16.

Electrochemistry and Batteries.

Use of Refrigeration with Storage Batteries.—L. JUMAU.—An abstract of a paper read before the Second International Congress on Refrigeration in Vienna. In certain processes for making storage-battery plates as well as in the operation of storage batteries the maintenance of low temperatures may be an advantage. It is a fact that the local action of sulphuric acid on the lead is reduced by lowering the temperature so that the batteries retain their charge for a longer time; on the other hand, the capacity of the battery suffers thereby. However, an advantageous influence of low temperatures is found in the formation of Planté plates with respect to the thickness of the peroxide layer obtained and, therefore, the surface capacity of the plate. Formation tests at different temperatures gave values of a surface capacity per square decimeter as follows: 0.274 amp-hour at 40 deg. C., 0.695 amp-hour at 27 deg. C., 0.905 amp-hour at 13 deg. C. An arrangement of cooling devices during the formation is therefore advisable in order to keep the temperature constantly low so as to get a uniform yearly product.—*Elek. u. Masch.* (Vienna), Dec. 11.

Units, Measurements and Instruments.

Reactance Power.—C. O. MAILLOUX.—A letter commenting on the recent proposals of Brunswick, Boucherot and Brylinski to find a suitable substitute for the term "puissance dewattée." He considers the corresponding English term "wattless power" to be even worse. From an international standpoint the translatability of the term is of importance. The following terms are considered most suitable: Puissance de réactance (reactance power); puissance de réaction; puissance réagissante; puissance réactive; puissance réactante. If the last term was selcted, the term puissance condensante could be formed for the case of a condensance or capacity. In this case "puissance réagissante" could be chosen as the most general term to comprise both puissance réactante and puissance condensante. (See also the letter of C. O. Mailloux in *Electrical World*, Nov. 24 (page 1244).—*L'Industrie Elec.*, Dec. 10.

Electrostatic Voltmeter.—R. BURROWS.—A note on a new electrostatic voltmeter design. There are two fixed coaxial metallic cylinders, with the same number of evenly spaced openings cut out of the cylindrical surfaces of each (see *A* and *B*, Figs. 4 and 5). In the space between the metallic cylinders and coaxial with them is supported a cylinder of a

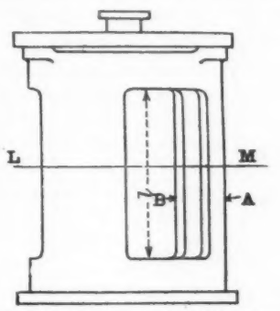


Fig. 4—Electrostatic Voltmeter.

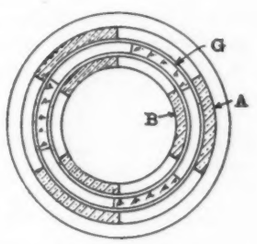


Fig. 5—Section Through L—M.

dielectric substance, the specific inductive capacity of which is different from that of air. This dielectric cylinder has the same number of evenly spaced openings in its cylindrical surface as have the metallic ones (see *G*, Fig. 5). The vibration in capacity is effected by the rotation of the dielectric cylinder between the metallic ones. However, the so-called dielectric constant of any material, instead of being a constant, increases more or less with time of exposure to the electric field, in many cases there being a sudden initial yield. Consequently if a steady potential difference were applied between the fixed cylinders there would be a more or less slow creeping action of the pointer attached to the dielectric cylinder. The instrument would, therefore, be useless for measuring steady potential differences. However, it could be used for measuring alternating potential differences if a proper dielectric substance is chosen. Flint glass seems to be the best for this purpose. The fundamental formulas for an instrument of this kind are given.—Lond. *Electrician*, Dec. 16.

Oscillograph.—F. EMDE.—A highly mathematical paper on the testing of oscillographs with respect to their inertia and damping effect.—*Elek. u. Masch.* (Vienna), Dec. 11.

Dielectric Constant.—M. P. FLOQUET.—A comparison of different methods of measuring the dielectric constant.—*Comptes Rendus*, Vol. 151, No. 11; *Jour. Franklin Inst.*, November.

Telegraphy, Telephony and Signals.

Telephone Cables.—W. A. J. O'MEARA.—A paper read before the (British) Institution of Electrical Engineers on submarine cables for long-distance telephony. After describing

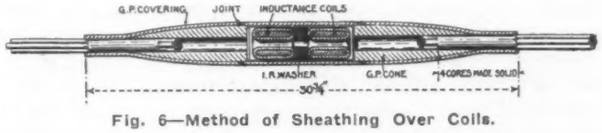


Fig. 6—Method of Sheathing Over Coils.

early submarine cables, the author discusses the three methods of increasing the range of telephonic transmission: (1) heavier conductors, (2) "continuous loading," (3) "coil loading." The last-mentioned method was found by the British post office to be the most suitable and was adopted in the new Anglo-French cable. A description of this cable, its laying and the tests when completed are given. The arrangement of the Pupin coils in the cable is shown in Fig. 6. The two double coils required for the four conductors of the cable, each coil being of slightly less than 6 ohms resistance and having an inductance of 0.10 henry at 750 cycles per second, are inserted at intervals of 1 knot (1.15 miles or 1.85 km), but the two

coils nearest the ends of the cable are inserted at a distance of only half a knot from the terminal apparatus, as experiments have shown that in this arrangement reflection losses are considerably reduced. Each double coil consists of two windings on the same iron core, and one winding is connected in series with each conductor. By this means the gradual change in permeability in the iron core, due to aging, will not affect the balance in the two limbs of the telephone circuit. Each coil is protected with a sheet of metal foil in order to exclude all possibility of the silk covering of the wires of the coils absorbing moisture from the cylindrical envelope of gutta-percha in which they are contained. The cores of the cable are connected to the envelope at its two ends by tapered solid gutta-percha joints. The diameter at the center of the envelope is 3 in. (76.2 mm) and at the cores where the joints terminate 1 in. (25.4 mm). An annular rubber distance-piece is inserted between the two coils of a set to give greater flexibility. The total length of the joint is 30.75 in. (781 mm). As the diameter of the cable at the points where the coils are inserted is increased, a larger number of sheathing wires are required at those points than over the conductors alone. This difficulty is overcome by starting a second layer of sheathing wires over the cores, about 27 ft. (8 m) from the center of the coil envelope and gradually working them into a single layer with those over the bulge. Finally they are terminated as a second layer again over the cores at a distance of about 27 ft. (8 m) from the center of the coil envelope. The attenuation constant of the loaded cable was found on test to be 0.0147. The paper is to be concluded in a subsequent issue.—Lond. *Electrician*, Dec. 16.

Wave Detectors.—H. Sutton and W. H. Eccles.—Sutton describes his work on a galena detector for practical work and suggests that the fall of resistance at the contact is due to the increase of mechanical pressure there through thermal expansion produced by the current. He compares the effect with the Trevelyan rocker experiment in which a hot fluted copper bar is placed on the edge of a block of lead and heats the contact, the sudden expansion of the lead throwing the bar up, the hot bar falling and touching the cooled lead, again heating it, the alternate heating and cooling of the lead keeping the bar rocking. The bar then gives out a musical note owing to the high rate of vibration. He found that a pair of galena contacts arranged in delicate flexible contact act the same as the hot copper-lead rocker. Eccles includes the fall of resistance at the contact in the "negative temperature coefficient of resistance of the contact" and remarks that since he has failed to find a useful oscillation detector constituted of a contact between substances possessing positive coefficients in the bulk one has always to deal in good detectors with bulk negative coefficients of resistance. For a certain effect he observed with the galena detector he gives the following explanation in preference to the "rocker" one of Sutton: The heat generated by the current at the constricted pathway across the contact warms the contiguous matter, thereby causing expansions which enlarge the area of contact. Consequently, the current density decreases, cooling follows, since there is other resistance in the circuit, and contraction reestablishes the former state of things. This cycle takes place very rapidly at a rate affected by the inductance and resistance of the telephone in the circuit.—Lond. *Electrician*, Dec. 16.

Submarine Cables.—C. Bright.—A continuation of his lectures before the Royal Naval War College on submarine cable laying and repairing. In the present instalment the author deals with jointing and splicing and the disposal of the cable sections aboard ship.—Lond. *Electrician*, Dec. 16

New Apparatus and Appliances

THE LIFE-TESTING AND ELECTRIC EQUIPMENT OF THE ENGINEERING DEPARTMENT OF THE NATIONAL ELECTRIC LAMP ASSOCIATION.

As early as 1903 the National Electric Lamp Association, at that time consisting of less than half a dozen member companies, undertook to determine the real performance of the lamps manufactured by its members and by outside companies. From 1906 to 1910 this work was carried on in the factory in Cleveland, Ohio, where Brush originally manufactured his arc-lighting machines, but with the growth of the association and the large increase of engineering research work it was found necessary to provide additional facilities.

In the new building, which is located on the site of the old factory, the lamp-life testing racks are placed in a room with walls entirely of glass, located on the roof, this location being chosen to provide ventilation to carry off the heat generated by so many incandescent lamps. In making plans for wiring, switching and transforming machinery it was estimated that the maximum demand would be 4000 amp at 120 volts, alternating current; 225 amp at 140 volts, direct current, and 25 amp at 280 volts, direct current. Energy is supplied by the Cleveland Electric Illuminating Company at 2300 volts, alternating current.

The transforming machinery at present consists of one 300-hp, 2300-volt, 60-cycle, three-phase synchronous motor connected directly to a single-phase, 120-volt alternating-current generator. The circuit is controlled by a Tirrill regulator with pressure wires running to the center of distribution on the racks. The regulator is adjusted so that the voltage at the racks shall be 120 volts. In addition to this there is a 30-kw, 140-volt direct-current generator, the voltage of which is controlled by a Tirrill regulator. This machine is used for supplying energy to storage batteries and to the direct-current lamps on test.

In order to have available for lamp testing every voltage which might be required in both alternating-current and direct-current service a very simple and flexible plan was adopted. Fig. 1 shows the construction of the regular alternating-current racks on which are placed all standard-base lamps requiring a voltage of from 6 volts to 300 volts. *A* and *B* are the busbars, which consist of three strips of ⅛-in. copper ½ in. wide. *A* is connected to the rack at *C*, thereby grounding the framework, which is made of 1¾-in. angle iron, and to which the bars carrying the receptacles are fastened directly. *B* is connected to a ½-in. copper rod *E*, which is insulated from the rack frame *J* by a porcelain insulator to the left at *D*. The portion of the sketch bearing the numbers 222-223, etc., represents standardized ¾-kw auto-transformers with their three terminals connected at *F*, *M* and *N* respectively. The rod *E* is duplicated on the other side of the rack, the unidentified leads being the connections from the transformers on the other side with the strips on the back of the rack. *N* is one of the asbestos-covered leads from the auto-transformer which connects with a narrow strip *H* insulated from the channel *O* by means of a strap of hard fiber. *O* is a bar or strip of channel brass 1⅛ in. wide and ¾ in. deep. The brass is ⅛ in. thick. The bar *P* is not connected with the transformer, as the location of the support *J* would interfere with it, therefore the sockets are connected directly across the primary leads, giving 240 volts in this case. On the 120-volt rack the voltage on this bar would be 120 volts. As a range of from 0.5 volts to 300 volts was desired for alternating current and from 75 volts to 260

volts for direct current some very elastic system was necessary. The problem was solved by the use of auto-transformers having a rating of ¾ kw for alternating-current circuits and individual rheostats for direct-current circuits. Two large transformers were installed, one stepping up the voltage from 120 volts to 240 volts and one stepping it down from 120 volts to 60 volts and 30 volts, the latter having two steps for the two

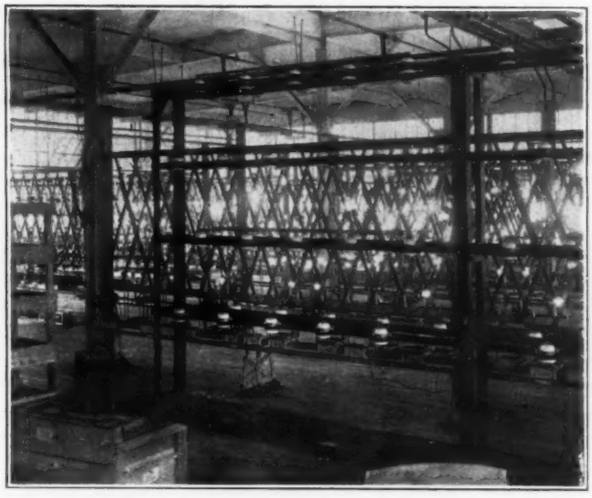


Fig. 1—Interior View of Lamp Testing Laboratory.

voltages. Auto-transformers are used throughout on account of their better regulation.

The lowest voltage is that used in miniature lamps. The installation for this style of lamp consists of three auto-transformers with 30-volt primaries and with secondaries of approximately 5 volts, 10 volts and 15 volts respectively. There are a number of taps brought out of the secondary windings from which it is possible to obtain voltages at ½-volt steps from 0.5 volt to 14.5 volts.

Passing from miniature to standard Edison bases, the next variation is obtained from seventy-five 30-volt primary transformers of standardized rating, to which there are connected 600 sockets. The ratio of transformation is such that voltages from 6 to 42 may be had in 1-volt steps. There are seventy-five 60-volt primary transformers, giving a range of from 54 volts to 90 volts in 1-volt steps. There are only 290 sockets available here, but the odd transformers are kept in reserve and may replace any in the racks if a particular voltage which is not at hand is desired. This same plan of substitution is carried out extensively on the 120-volt racks and saves considerable room. The three preceding sets of voltage ranges have been taken from the large step-down auto-transformer already mentioned, while the 120-volt racks, which are most numerous, are connected directly to the generator. There are 2000 sockets in this set with a range of from 90 volts to 180 volts, to supply which there are used altogether 575 transformers. On the last set there are 1000 sockets with 275 transformers with 240-volt primaries, giving a secondary range of from 180 volts to 300 volts.

In addition to the multiple racks there are eighty street-series sockets operated from a separate transformer having a number of taps, which, together with a set of variable resistances, make it possible to obtain any current used in street-series lamps.

An extra emergency multiple rack with 360 sockets is being installed which covers the entire range of voltages desired, one-quarter being run from the 30-volt circuit, one-quarter from the 60-volt, one quarter from 120-volt and the remainder from 240-volt.

For direct current there are 110 sockets for 280 volts and 210 for 140 volts, each outlet being equipped with an adjustable resistance by means of which the required voltage may be obtained. Energy for these circuits is obtained from the direct-current generators, already described, and is supplied at 140 volts and 280 volts.

All of the life-testing racks are of fireproof material throughout. Lamps put on these racks are placed on a circuit having a voltage which is determined by rating the lamps at a specific consumption of a certain number of watts per candle. For each lamp there is a record card giving all the necessary information concerning the lamp, and at certain predetermined periods the lamps are removed and photometered, this being carried on until they burn out.

In order to determine the actual time that the lamps are on test and also to insure that no sudden rise in voltage may occur or that the circuit may not be interrupted without a time record the greatest precautions have been made for mechanically recording the time and for means of calling attention to any excessive change in voltage should it occur.

A recording voltmeter is attached to the 120-volt racks in the test-room and whenever the voltage varies more than 1 volt above or below 120 a bell rings. In addition to this the record of the meter is carefully watched and the regulator is adjusted so that there shall be not more than about 0.2 volt variation under ordinary conditions. If the voltage increases to more than 123 volts the main circuit-breakers on the switchboard are automatically tripped. As an excess voltage on the lamps will materially decrease their life, it is necessary that all of these precautions shall be taken or otherwise the results of the tests will be of little value.

A clock operates a shaft to which are attached four electromagnetically controlled clutches. These electromagnets are placed in series with pilot lamps in different sections of the test-room and in case the circuit on these racks is opened the clutches are thrown out so that recording mechanism in the form of counters which indicate hours ceases to work. By referring to these counters the time during which energy has been supplied to the rack is easily obtained. This entire

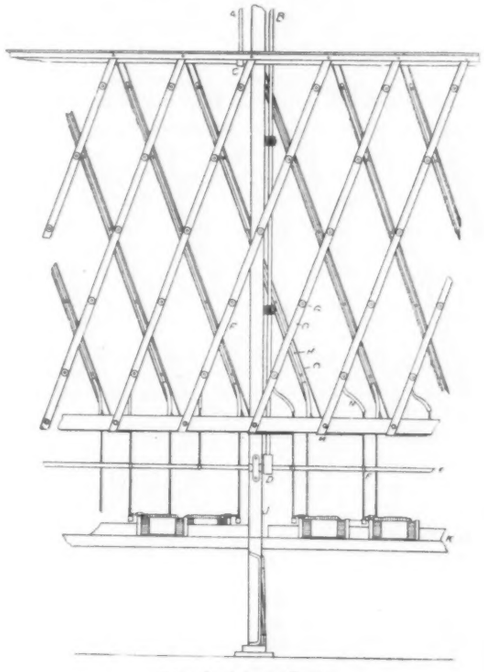


Fig. 2—Lamp Rack.

mechanism was devised and constructed by the engineering department.

Some idea of the magnitude of this lamp testing may be gained by considering that at one period very recently more than 3500 lamps were on the racks at one time. Approximately 2300 lamps are put on test every month, and nearly 18,000 cp measurements are made to determine change of candle-power

with life. Anyone who has seen the light given by these lamps at night may be able to appreciate slightly the energy consumed in making these tests and the expense incurred for the main object of determining the life and peformance of the lamps manufactured by the member companies of the National Electric Lamp Association.

PRIMARY BATTERY FOR USE WITH TUNGSTEN LAMPS.

Among the inherent defects of primary batteries which have rendered them more or less unsatisfactory for many purposes may be mentioned the rapid deterioration of the elements with time when not in use and the rapid falling off in the e.m.f. when the batteries are in service. These defects are attributable to the local action at the zinc electrode, together with the polarizing influence of the electrolyte upon the electrodes.

It is now claimed that these defects have been largely removed in a form of primary battery which is being placed upon

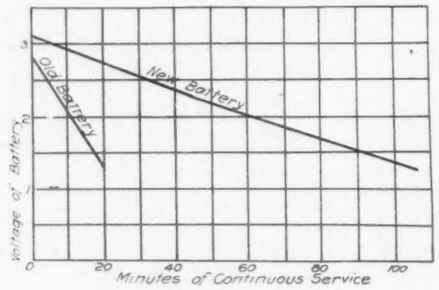


Fig. 1—Comparative Tests of Batteries, Size 2¼ x 1¼ x ⅝ In.

the market by the American Ever Ready Company, 304 Hudson Street, New York.

In comparison with the usual type of primary battery the new battery embodies improvements in electrolyte, electrodes and insulating materials. In the usual form of battery use has always been made of manganese ore. In the new battery for the purpose of minimizing the polarization there has been substituted for manganese ore the manganese hydrate. To minimize local action around the zinc electrode use is ordinarily made of mercury. In the new form of battery there has been substituted therefor mercury sulphate. In place of the

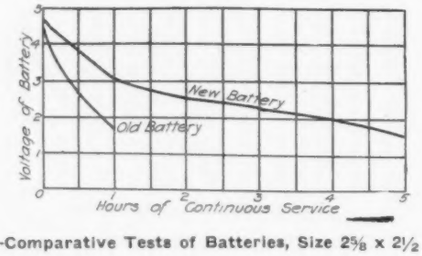


Fig. 2—Comparative Tests of Batteries, Size 2⅝ x 2½ x ⅞ In.

blotting paper separator generally used between the electrodes. in the new battery use is made of a special form of insulation asserted to be much superior for the purpose.

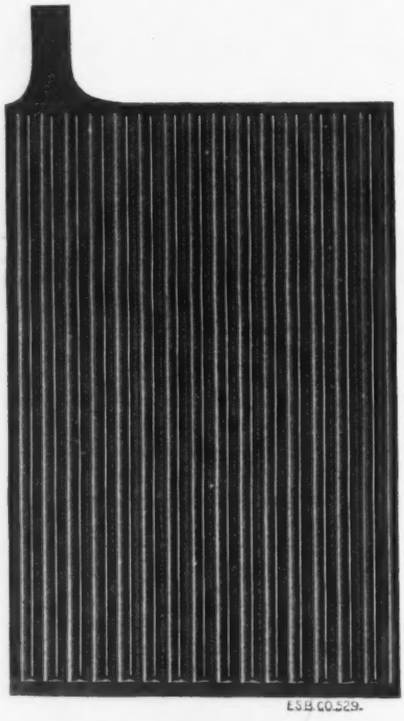
The active life of the battery that is now being placed upon the market is said to be four times as great as that of the usual primary battery, while the battery maintains a much higher and more uniform e.m.f. throughout its life. These facts are shown in the accompanying illustration representing service tests made upon the batteries.

Fig. 1 shows the results of a continuous-service test on an old-style zinc-carbon battery having dimensions of 2¼ in. x 1¼ in. x ⅝ in. supplying energy to a certain tungsten lamp, and a similar test on a new battery having identical dimensions when supplying energy to a tungsten lamp of exactly the same style, kind and size. Fig. 2 gives an equivalent comparison of continuous tests on old-style and new batteries having dimensions of 2⅝ in. x 2½ in. x ⅞ in.

ELECTRIC VEHICLE BATTERY.

The Electric Storage Battery Company, of Philadelphia, has recently developed for the market an electric vehicle battery which will be called the "Ironclad-Exide." It is said that long tests have already proven the dependability of the new battery, which was the invention of a Frenchman, the American rights for which were secured by the company about four years ago.

The positive plate of the battery, shown in the accompanying illustration, is so designed as to prevent the loss of active material. The plate consists of a metal-conducting top and bottom bar connected by vertical conducting rods. Each rod is surrounded by active material, which in turn is protected and held in place by a slotted hard-rubber tube. This tube carries a vertical rib on each side which takes the place of wood



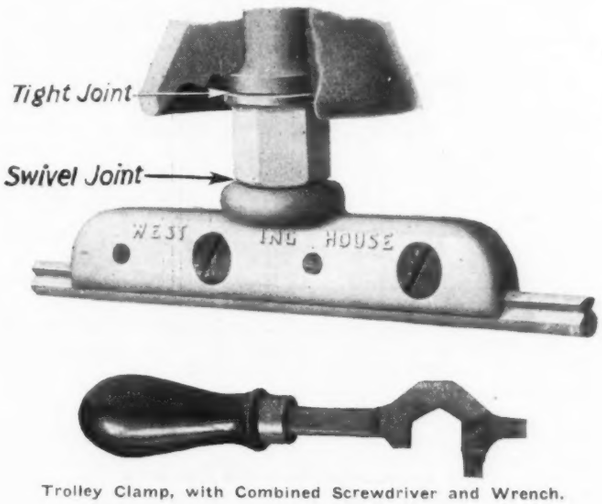
Storage-Battery Plate.

separators, used with the standard "Exide" type of positive plate, and makes the use of rubber separators unnecessary. A thin, flat wood separator spaces the positive from its negative. The negative plate is a modified "Exide" negative plate thickened and improved to enable it to withstand not so much the increased output as the greatly increased life of the new positive plate.

For the new battery the following points are claimed: It gives from two and one-half to three times as long life as the older type. Active material does not shed from the plates, which eliminates the necessity for cleaning the cells. It gives increased mileage and maintains this high feature during the greater part of its life. The battery can be installed in standard "Exide" battery jars so that vehicle users having "Exide" batteries can substitute the new batteries when requiring renewals.

TROLLEY CLAMP.

The Westinghouse Electric & Manufacturing Company has just placed upon the market a new trolley clamp that embodies several improvements. The swivel joint permits the boss to be screwed up tight to the stud, thereby keeping out moisture and preventing corrosion and wear of threads. The two side caps are absolute duplicates and thus the clamping pressure is

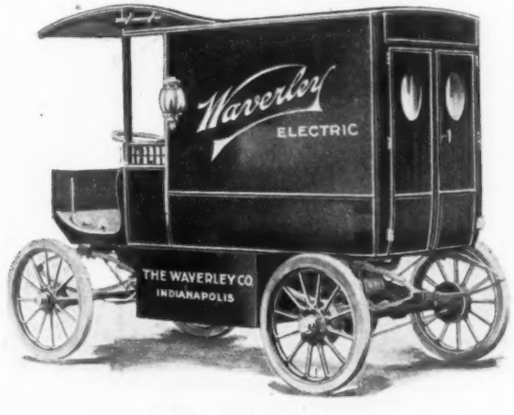


Trolley Clamp, with Combined Screwdriver and Wrench.

uniform. Having only two countersunk holes in each side, the clamp is stronger than the clamping pressure, consequently more permanent. A few drops of solder in the swivel joint after the clamp is installed adapt it for feeding. The clamp can be installed with an ordinary screwdriver and a monkey-wrench or with a combined screwdriver and wrench especially designed for this service.

ELECTRIC DELIVERY WAGON WITH SHAFT DRIVE.

As will be noted from the accompanying illustration, the shaft method of driving which is employed with high-grade pleasure cars has been applied by the Waverly Company, Indianapolis, Ind., to a light delivery wagon. The motor shaft runs parallel with the rear wheel shaft and is connected thereto by means

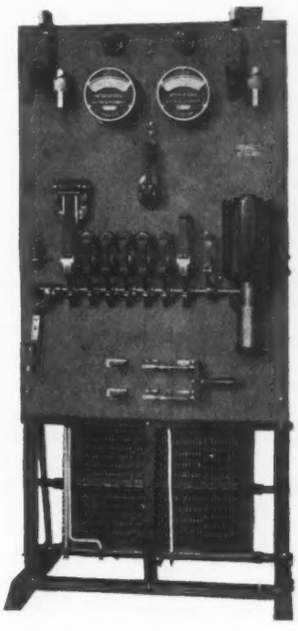


Electric Delivery Wagon.

of herringbone gears. It is said that of all types of drive the herringbone gear possesses the highest efficiency. The model of wagon here illustrated is particularly suited for department stores, milliners, grocers, laundries and all that class of dealers who make quick deliveries. The motor is of such size and the battery carries such an amount of energy that the vehicle can cover from fifty to seventy-five miles on one charge, the speed maintained being from ten to fifteen miles per hour.

LARGE AUTOMATIC FIRE-PUMP STARTER FOR CHICAGO CITY HALL.

For controlling the 150-hp motor which will operate a fire pump delivering 750 gal. of water per minute to a fire-protection tank in the new Chicago City Hall a special Schureman-type automatic starter with hand attachment has been built by the Cutler-Hammer Manufacturing Company, Milwaukee. The starter is controlled from a float-type switch at the tank on the 320-ft. level and closes the motor circuit automatically to



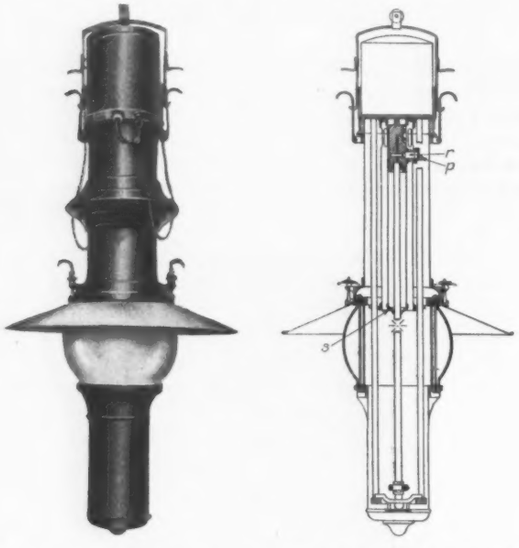
Automatic Fire-Pump Starter.

fill the tank as soon as the water level reaches a predetermined lower limit. In this way the quantity of water held in the tank is maintained at a prescribed amount. The accelerating switches are closed in proper succession by cams on the starting shaft, which is manipulated by a solenoid against the resistance of an adjustable dashpot. In the closed position the shaft is held by a locking magnet. In case of injury to the float mechanism a handle is provided by which the starting switches can be operated by hand. A double-throw switch is provided for connecting over to the terminals of the large storage battery placed in the building to guard against the possibility of interruption of the water-power transmission line of the Sanitary District of Chicago, which supplies the City Hall electric service. Pilot lamps are provided for showing the condition of the circuits. All of the parts are of brass or copper-plated, and when installed the starting panel will be inclosed in a protecting case.

ENCLOSED 70-HOUR FLAMING-ARC LAMPS.

The Excello Arc Lamp Company, of New York City, has brought out new alternating-current and direct-current long-hour burning flaming-arc lamps intended for steel-mill and street-lighting service. Both types of lamp have vertical electrodes and by shutting off the supply of air after the fashion common to inclosed arc lamps of the ordinary type an electrode life of seventy hours is obtained on a single trimming. By the total inclosure of the arc, however, the problem of disposing of the fumes arising from the arc which cannot be disposed of by ordinary methods of ventilation confronted the manufacturer. The deposit is got rid of by a novel arrange-

ment of the globe and burning chamber. Above the arc itself a long, chimney-like metal tube is arranged, which owing to its large radiating surface causes the lighter gases to condense inside it and in the upper and cooler portion of the lamp where the deposit accumulates and is easily brushed out when the lamps are retrimmed. Inside the outer opalescent globe there is a clear cylinder of glass surrounding the arc and open at the top and bottom. By referring to the engravings the construction of the lamp will be apparent. A constant circulation is thus set up and the ash or deposit is so completely got rid of that the loss of light after seventy hours' burning is insignificant. The mechanism of the direct-current lamp is of the differential pattern, while in the alternating-current lamp it is of the motor type. The mechanism is housed in the upper compartment of the lamp, where it is immune from the gases, deposit and heat of the arc. It is a trifle more rugged than the usual mechanism and the construction throughout is good. The electrodes are self-focusing; that is, the negative and positive electrodes both feed, thus maintaining the arc in a fixed position within the globe. The arc e.m.f. is about 40 volts to 45 volts and the current consumption is 8 amp. Special electrodes are employed, each 350 mm long. In the direct-current lamp the upper or negative electrode is 13 mm in diameter and the lower or positive electrode is 15 mm in diameter. In the alternating-current lamp both electrodes are 13 mm in diameter. The light distribution curve of the lamp is shown in Fig. 3. The lamps are easily retrimmed. The lower metallic section, including the globes and shade, is removed as one piece. After the lower electrode holder has been drawn down to its lowest position the upper electrode holder, which fits snugly in the metallic tube, may be reached by a key which passes through the valve opening *p* and the hole *r* to the set-screw clamping the electrode in place. The lower electrode is inserted in the usual manner and centered with the upper electrode. The specific consumption of the lamp per mean lower hemispherical candle-power is 0.35 watt.



Figs. 1 and 2—Excello Long-Hour-Burning Flaming-Arc Lamp.

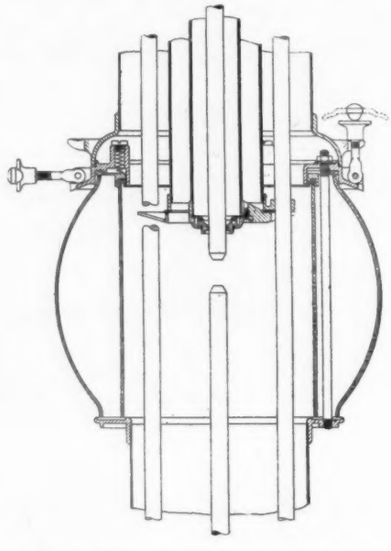


Fig. 4—Cross-Section of Arc Chambers.

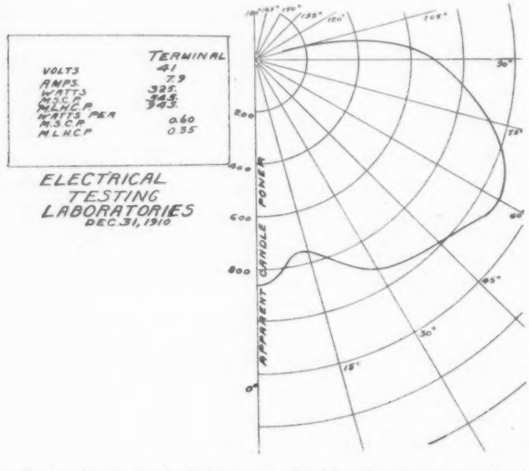
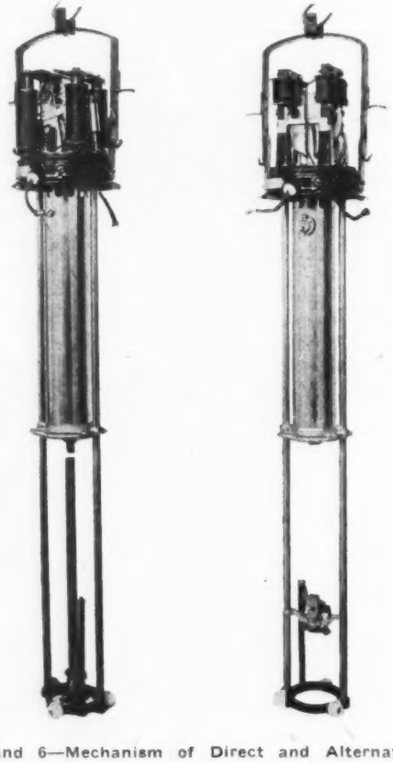


Fig. 3—Vertical Distribution of Light, Excello Seventy-Hour Flaming-Arc Lamp.



Figs. 5 and 6—Mechanism of Direct and Alternating-Current Lamps.

Industrial and Commercial News

THE WEEK IN TRADE.

COMMERCIAL business during the last week of 1910 showed no improvement over that in the preceding weeks. Post-holiday quiet was apparent in all lines of trade and industry, and both commercial business and manufacturing activities felt the effect of the inventory-taking period. The wholesalers and jobbers were practically without orders during the week, which is not unusual, however, at the close of the year. Retailers did little business, although reductions and bargain sales did something to stimulate buying. The general reports of the holiday trade are satisfactory, although in many cases the volume did not come up to that of the previous year. The best reports came from the Western section of the country, where the benefits of the free marketing of agricultural products have been distinctly felt. Holiday trade in the industrial centers was to some extent restricted, due to the fact that a large percentage of the manufacturing plants are either operating at part time or have laid off a number of their employees. In the steel and iron districts this was especially noticeable, where the majority of mills are running at less than 50 per cent. of capacity. Reports from the South were especially good, owing to the early marketing of cotton at high average prices. The week added nothing of encouragement to the iron and steel industry. But few orders were placed and there were no developments which made more encouraging the outlook for 1911. There was much discussion as to whether prices will be cut on a so-called open market basis. The advocates of reductions and the standpatters seem to be fairly evenly divided, but the policy of the steel trade will not be known until after the conference that will be held in New York on Jan. 11. While some railway track supplies were contracted for during the past week, there were very few orders for rails. The recent orders of the Pennsylvania Railroad and the New York Central have not as yet been finally closed, owing to the disinclination of the mills to accept the specifications. Collections have been generally fair, especially in the West and South. In other sections there has been no improvement. Business failures for the week which ended Dec. 29, as reported by *Bradstreet's*, were 251, as compared with 271 the previous week, 257 in the corresponding week of 1909, 299 in 1908, 185 in 1907 and 220 in 1906.

THE COPPER MARKET.

PRACTICAL stagnation marked the closing week in the copper market for the year 1910. Prices were weak, and while the selling agencies continued to quote electrolytic at 13 cents, it was generally understood that what few sales were made were negotiated at something like 12⅝ cents or 12¾ cents. At no time in the past several months has the demand for copper been quite so dull as during the past week. While the operators in the market believe, or at least assert, that there will be a revival in demand during January, there is no real basis upon which to predict such a hope. It is probable that the figures

Standard Copper.	Bid.	Asked.	Settling Price.
Spot	12.00	12.15	....
December	12.00	12.15	12.07½
January	12.00	12.15	12.07½
February	12.00	12.15	12.07½
March	12.00	12.15	12.07½

The London market, Dec. 30, was as follows:

	Noon.	Closing.
	£ s d	£ s d
Standard Copper, spot	55 17 6	56 0 0
Standard Copper, futures	56 13 9	56 16 3

Extreme fluctuations for this year:

	Highest.	Lowest.
Standard	13.50c	11.70c
London, spot	£62 0 0	£52 15 0
London, futures	65 18 9	53 7 6
Best selected	65 10 0	57 15 0

of the Copper Producers' Association will show a considerable increase of surplus stocks during the month of December and there is every reason to expect a similar increase during the month of January. The domestic demand is almost nothing at the present time and there is no life in the London market. During the week the report of the United States Geological Survey was made public, giving the official production of copper for the year 1909 from both domestic and foreign ores as 1,391,021,454 lb. This was the largest output in the history of the industry and exceeded that of the year 1908 by 253,059,046 lb. It is estimated that the production of copper in 1910 will amount to 1,448,000,000 lb. This enormous production, which is in excess of the consumption, is being continued at the present time in spite of the fact that quite a number of mines have endeavored to curtail their output. It must also be remembered that there are large stocks being carried in the warehouses of Europe which, while they do not figure in the official reports, are still at the disposal of consumers. The exports for December were not particularly large, amounting for the month to 28,794 tons. The daily call on the Metal Exchange up to and including Dec. 30 quoted standard copper as per the accompanying table.

INDUSTRIAL AND COMMERCIAL NOTES.

General Electric Company Sales.—An official of the General Electric Company states that the total sales made by that company during 1910 will amount to something more than $70,000,000. Orders booked will amount to about the same figure. The company therefore ends the year with just about the same amount of business on hand that it had at the beginning. In all of the plants of the company there are now employed about 35,000 men. During the year the company has spent in the neighborhood of $5,000,000 for plant extensions and improvements. This has mostly been in the nature of additions to the existing plants, although a large amount of new construction has been commenced at Erie, where foundries and machine shops are being built. A new lamp factory has also been built at Toledo. According to this official, the total addition to the floor space of the General Electric plants during 1910 was in the neighborhood of 1,400,000 sq. ft. While quite a number of large orders were taken during the year for heavy apparatus for lighting concerns, a larger percentage of the business was for the lighter classes of machinery than in any previous year. There has been a rapid development in the use of small motors in manufacturing concerns, and there has also been a very heavy increase in the department of household appliances. The busiest single department of the General Electric Company during the year was the lamp department. With the exception of the year 1907, the year 1910 shows the largest business the General Electric has ever had. The plants, however, have not been operating at full capacity, because the numerous extensions and improvements made within the last few years have increased the capacity to about $100,000,000. This authority states that it is the opinion of many of the officials of the company that 1911 will not exceed 1910 in volume of business. In fact, many of the officers of the company expect some recession during the coming year.

Crocker-Wheeler Company.—Both in gross business and in net profits the Crocker-Wheeler Company, Ampere, N. J., under the guidance of Dr. S. S. Wheeler, president, and Gano Dunn, vice-president and chief engineer, has exceeded in 1910 its record of 1909. As it closes its twenty-third year of independent existence it looks forward to increasing prosperity under the same management and upon the same lines of business policy. "The figures for the year are not yet obtainable," said an official of the company in discussing the year's business, "but they will undoubtedly show the largest volume of orders in the history of the company. With a complete line of induction motors, besides the Crocker-Wheeler direct-current motors which the company has been manufacturing since 1888, there is no motor-drive problem, large or small, which cannot receive expert handling by the engineers of the company. During the past year the company has continued to supply to the steel mills its Form 'W' rolling mill motor, which set the fashion in this particular line and which is used in large quantities throughout the steel industry. One of the principal achievements of the company in 1910 was the launching of its 'Remek' lighting transformers, which represent a radical advance in the art of transformer design. The company has continued to build generators of all capacities, both alternating current and direct current, and has already booked orders for important generating apparatus to be delivered during 1911. In the turbo-alternator field the Crocker-Wheeler Company is establishing itself as an important independent manufacturer of the electrical end of such equipments."

Lighting Companies Prosper More Than Tractions.—A representative of the largest electrical manufacturing concern in the country, who keeps in close touch with the conditions of the electrical industry, says that during the year 1910 the light and power companies have shown much greater prosperity than the traction companies. He says that 90 per cent of the orders for large generating apparatus have come from the light and power companies. This, he explains, is due to the fact that in many sections of the country the traction companies are not in the best of shape. He points to the fact that in New York, Philadelphia, San Francisco, Chicago, Cleveland, Toledo, Detroit and many other important cities the traction companies are having either financial or franchise difficulties. This has made the moneyed interests less favorable to traction securities than those of lighting companies. As he puts it: "The traction companies have a much harder row to hoe than the light and power companies. The public is in closer touch with the traction company and makes far greater demands on it than it does on other public service companies. There is a constant effort to increase the service; the hauls must constantly be made longer; improvement in equipment is perpetually demanded, and there is absolutely no chance of increasing the rate of the fare. Then, again, the municipalities always regard the traction companies as fair victims for taxation increases. It is a constant struggle for the managers of traction properties to keep their expenses down within a profitable range. The lighting companies do not have this difficulty. They are not in endless warfare with either the city officials or with the public. The demand for their service is always expanding, and there is very little clamor for reduction in rates. For these reasons the manufacturing companies have found during the past year that the lighting companies are much better customers and in much better condition to buy than the tractions."

Insulated Wire Trade in 1910.—It would be stretching a point to say that the insulated wire trade during the past year had been satisfactory. In discussing the matter a representative of one of the largest manufacturing concerns in the country said that while the total volume of business had probably been larger than that done in 1909 it had not been up to the expectations of the manufacturers, and the year closed under rather gloomy conditions. "The reason that trade was so unsatisfactory this year," said this authority, "is that it was so definitely bunched within the limits of a few months. In January and February orders were moderate, but probably as much as manufacturers could have expected. Beginning with March and running well up toward the end of July there was a great rush of orders. Business came to us in such volume that we began to think 1910 would be our record year. Then there was a slump, a heavy slump, and from Aug. 1 to the end of the year orders were few and small in size. The business for the last five months of the year was so light that it entirely offset the prosperity of the first half of the year. At the present time business is very dull. The figures for the year, however, are somewhat deceptive as far as the real earnings of the insulated wire companies are concerned. We have been badly handicapped by increases in manufacturing costs. During the early months of the year, when orders were coming in, crude rubber and yarns were very high, but owing to the competition of outside manufacturers we could increase our selling prices very little. The result was that during the period of our best business we operated on a narrower margin than ever before in our history. When crude rubber and yarn declined in the early fall business also went down to the zero mark and we got no benefit from the cheaper raw material. I would not venture a prophecy as to 1911. I think much depends upon what is done in Washington, but I do not consider the outlook at all optimistic."

Westinghouse Electric & Manufacturing Company.—Although the fiscal year of the Westinghouse Electric & Manufacturing Company does not end until March 31, it is expected that the current year will show the largest earnings and the best profits in the history of the organization. The earnings for the calendar year 1910 have been larger than ever before recorded. A representative of the company, in speaking of the business done last year, said that the average sales throughout the twelve months were almost $3,000,000 per month. These figures do not include the income from investments, royalties, etc. It is estimated that the gross earnings for 1910 will be between $34,000,000 and $35,000,000. The general character of the work done was in the lighter class of electrical apparatus. The busiest section of the manufacturing plant was the railway motor department. Almost throughout the entire year this department has been working overtime. There was also a heavy business done in transformers and in small commercial motors. Orders for large turbo-generator units were not as numerous as heretofore, although some good contracts were made. It is estimated that the factory cost of the business done will be between $28,000,000 and $29,000,000, leaving a net profit in the neighborhood of $6,000,000. In October the company was employing about 19,000 men, which is an increase of more than 6000 over the same period last year. During November and December orders were not so plentiful as in some of the previous months of the year, but a good volume of business was still contracted for.

Allis-Chalmers Company.—The record of the Allis-Chalmers Company for 1910, like that of many other manufacturing companies, shows a streak of fat and a streak of lean. The fiscal year of the company ends June 30, so that any estimate of the business done in the calendar year is largely guesswork. An official of the company made the statement that, according to the data now at hand, the business done in 1910 would be about the same as that done in 1909. This was about 80 per cent better than the business of 1908. During the past year, according to this authority, the electrical business done by the company was good, the orders for mining machinery and for power plant apparatus were satisfactory, the orders for flour mill machinery were enormous and there was a fair demand for gas engines and for steam turbines. The demand for reciprocating steam engines was very poor, and the general machinery demand was only moderate. Quite a number of good orders were taken for hydroelectric apparatus, but hardly as many of these were received as had been anticipated. Beginning with March 1, there was a fine run of orders and business was booming. This continued until toward the end of July, when there came a slump, from which there has been little recovery. The last five months of the year were extremely dull, and so far there is little prospect of improvement in 1911. During the past two or three months the plants of the company have been operated at less than 50 per cent of capacity.

Motor Vehicle Associations Consolidate in Boston.—The motor truck associations existing in Boston have been consolidated under the name of the Boston Commercial Motor Vehicle Association, and there will hereafter be but one association of dealers in this field in the city. Electrical interests are represented by Day Baker, of the General Vehicle Company, who is the secretary of the new association. Present members of the Boston Motor Truck Association and of the Commercial Motor Vehicle Association, of Boston, have been admitted to membership, and an eligibility clause has been adopted limiting future membership to actual dealers in commercial motor vehicles. The new association will not attempt to conduct a separate motor vehicle show during the present season, but will co-operate with the Boston Automobile Dealers' Association in the annual show to be held in Boston in March. The new association will endeavor to work for the establishment of motor truck ways in the major teaming thoroughfares of the city, following a thorough discussion of this matter a few days ago by a motor vehicle committee of the Boston Chamber of Commerce. This committee was appointed to consider means of reducing the congestion of Boston streets, and the power of electric and gasoline vehicles to accomplish this was discussed at some length at the public meeting.

Poulsen Wireless Company.—San Francisco capitalists have recently organized a company under the laws of Arizona, with $25,000,000 authorized capital, called the Poulsen Wireless Company, to exploit in the United States the wireless telegraph and telephone patents of Valdemar Poulsen, of Copenhagen. Beach Thompson is president of the new company. E. W. Hopkins, of the Hopkins estate; George A. Pope, of the Pope estate; Howard P. Veeder, formerly interested in the Stanislaus River Power Company, and a number of other prominent California capitalists are interested in the project. It is stated that the company will not be ready to enter the commercial field for some time. Its work at present will consist of a series of experiments and tests. Communication both by wireless telegraph and wireless telephone has been established between San Francisco and Stockholm.

Compressed Air for Anaconda Mines.—It is stated in Butte that the Anaconda Copper Mining Company will have its air-compressor plant in operation about Feb. 1. The electrical equipment which will operate this plant will be in readiness by that time. The energy is furnished by the Great Falls Water Power & Townsite Company, and is transmitted a distance of 130 miles. This transmission is made over two separate lines. Near the center of the transmission lines is a switching station equipped with oil switches and lightning arresters, by means of which a cross-over connection can be made and one-half of either line can be cut out while the remainder is in operation. Above the power-carrying lines are two galvanized steel strands grounded at each tower, which will serve as protectors against lightning. A 100,000-volt substation has been constructed on Anaconda Hill, from which the energy is to be distributed. The compressor plant consists of three Nordberg direct-connected variable capacity air compressors, each with a capacity of 7000 cu. ft. of free air per minute. When operated at full load the energy required to drive these compressors is 3000 hp. It is estimated that the substitution of air for steam by the Anaconda company will reduce the cost of producing copper 1½ cents per pound. The plant already completed is intended to serve only the Mountain View, High Ore and Diamond mines. If the result is as successful as is anticipated the other mines of the Anaconda company will be similarly equipped.

Hickory (N. C.) Hydroelectric Development.—Construction on the development of the hydroelectric plant of the Water Power Electric Company on the Catawba River at Hickory, N. C., is to begin next week and be pushed to completion. The chief engineers are Connell & Connell, of 90 West Street, New York City, and Louis R. Abel, who has had his office at 258 Broadway, has gone to Hickory as the resident engineer. Colonel Marcellus E. Thornton, who is the president of the company, and also president of the Thornton Light & Power Company at Hickory and of the Hickory Railway Company, has labored unceasingly during the last five or six years for this consummation. He was formerly president and general manager of the Main Jellico Mountain Coal Company, at Kensee, Ky., with a capital stock of $500,000, of which he owned considerably over a majority. This construction, it is thought, can be completed in fourteen or fifteen months. Two large industrial plants will be constructed during the same period, located near the dam and power house. It is estimated that 9000 hp will be developed.

Electrical Engineers' Equipment Company.—The Electrical Engineers' Equipment Company, of Chicago, manufacturers of high-tension power-house and line-construction specialties, has enlarged its facilities by leasing for its office and factory the building at 10 and 12 North Desplaines Street, Chicago, which will hereafter be the headquarters of the company. This building is three stories high and 50 ft. wide and contains approximately 12,000 sq. ft. of floor space. The machine shops and other manufacturing departments of the company, as well as the store house, will be concentrated here. The Electrical Engineers' Equipment Company is one of the newer companies in the electrical manufacturing business, but it has been successful. Percival Steele is president of the company, and A. D. Fonger is assistant manager.

Chicago Telephone Rates.—A reduction of from 8 per cent to 10 per cent in the rates for service charged by the Chicago Telephone Company is recommended in a report of experts employed by the City Council. Action on the report was postponed until the members of the Council, telephone company officials and others interested have a chance to be heard. The experts report that the telephone company is earning 10 per cent on its investment and is not entitled to earn more than 8 per cent. The investigation covered a period of six months and took in every branch of the service. The report is practically opposite to one made some time ago by the Arthur Young Company, public accountant, and D. C. & Wm. B. Jackson, engineers. This former report favored an increase in telephone rates.

To Use Storage-Battery Cars.—The Public Service Commission of the First District has set Jan. 10 as the date of a hearing upon the application of Frederick W. Whitridge, receiver of the Forty-second Street, Manhattanville & St. Nicholas Avenue Railway Company, for permission to change the motive power on that line from horse cars to storage-battery cars. These cars have been experimentally in use on this line for some time. They are the cars built by the Third Avenue Railroad Company and equipped with batteries furnished by the Gould Storage Battery Company. A number of these cars are now running on the Twenty-eighth Street and Twenty-ninth Street line under an operating contract with the Third Avenue Railroad Company.

Developing Tungsten Properties.—Development work on the tungsten properties of the Blue Grouse Mountain, northeast of Spokane, Wash., is progressing rapidly. Buildings have been erected for the accommodation of a large number of workmen, and the work will be pushed forward as soon as the weather permits. The shaft is being sunk at a point where the three veins of ore join, about 40 ft. below the surface. The ore in these veins runs from 40 per cent to 70 per cent tungsten. The company has about thirty tons of ore sacked, which it is estimated will be worth from $300 to $500 a ton.

Henry L. Doherty & Company's Christmas.—The firm of Henry L. Doherty & Company made a Christmas present to each of its employees, from the highest officials to the office boy, of 20 per cent of the yearly salary. In addition to this the heads of departments and those holding important positions participated in the profits of the company for the year.

Financial.

THE WEEK IN WALL STREET.

WHILE actual transactions last week were a trifle better than the week previous, and while prices of stocks were a trifle stronger, market conditions taken as a whole were thoroughly discouraging. There is no confidence left even among the professional traders and the public has long since ceased to be a factor in the market. It is doubtful if a year ever closed more dismally than did 1910. In 1904 and 1907 the market was much more demoralized and prices were far lower, but the Street was at least cheered with some measure of activity. Traders in those years had positive opinions and were not afraid to back them with their money. To-day there is general uneasiness and few professionals are daring enough to make deals involving important amounts. Just at the present time the reason assigned for this condition is the general anxiety felt over the anti-corporation prosecutions. With two anti-trust suits involving enormous amounts of capital nearing decision in the Supreme Court, with the prosecution of the so-called Electrical Trust ready to begin, and with the question of railroad rates still hanging in the balance, speculators and investors alike may well be timid and nervous. It is the general opinion of the trades that upon the decisions now imminent hangs the fate during the early months of the new year. In the bond market during the past week there was some increase of activity and it begins to look as if a genuine investment demand were being developed. The money market advanced sharply during the week and call money rose at one point to 7 per cent, the highest rate since May. Rates Dec. 31 were: Call, 3¾@4 per cent; ninety days, 4½ per cent. The quotations in the table are those of the close Dec. 31.

NEW YORK.

	Dec. 23.	Dec. 31.	Shares sold.		Dec. 23.	Dec. 31.	Shares sold.
All. Ch.....	⅜	8*	300	Int. Met., pf.	54¼	53½	10,250
All. Ch., pfd.	30*	29	300	Mackay Cos..	92½*	92½*	——
Amal. Cop...	62⅝	61⅝	64,200	Mackay C.,pf.	76*	75¼*	100
Am. D. T...	20½*	20½*	——	Man. Elev...	139*	138⅛*	1,010
Am. Loco....	36½	38½	2,625	Met. St. Ry..	15*	15*	——
Am. Loco.,pf.	105½*	108*	200	N.Y.&N.J.Tel.	139¼*	139¼*	——
Am. Tel. & C.	80*	80*	——	Steel, Com...	72⅛	72⅛	288,978
Am. T. & T..	142½	140⅛	7,100	Steel, pfd....	116⅞	116⅜	6,380
B. R. T.....	75½	75¼	5,650	W. U. T....	73	72½	1,850
Gen. Elec....	155	151*	2,950	West'h, com.	66½	65½*	1,200
Int.-Met. ...	19½	19½	7,200	West'h, pfd..	122*	122*	——

PHILADELPHIA.

	Dec. 23.	Dec. 31.		Dec. 23.	Dec. 31.
Am. Rys.....	42½*	42*	Phila. Elec.....	16¼	16⅜
Elec. Co. of A.....	11⅝*	11⅝*	Phila. R. T.....	18¼	18⅜
Elec. St. B'ty.....	48¾	48¼	Phila. Trac.....	84*	84
E. S. B'ty., pfd.....	30*	30*	Union Trac.....	43	43¼

CHICAGO.

	Dec. 23.	Dec. 31.		Dec. 23.	Dec. 31.
Chi. City Ry.....	170*	170*	Chi. Tel. Co.....	123	120
Chi. Rs., Ser. 1.....	92½*	92½*	Met. El. Co.....	21*	23*
Chi. Rs., Ser. 2.....	25¼	25¼	Met. El., pfd.....	65*	69
Com. Edison.....	115½	113*	Nat'l Car.....	117	119*
Chi. Subways.....	4	4⅝	Nat'l Car., pfd.....	117½*	117½*

BOSTON.

	Dec. 23.	Dec. 31.		Dec. 23.	Dec. 31.
Am. T. & T.....	142½	140¼	Mex. Tel.....	4*	4*
Cum. Tel.....	149*	145*	Mex. Tel., pfd.....	6⅜	6*
Edison E., Ill.....	285	288	N. E. Tel.....	138	138
Gen. Elec.....	155*	152½	W. T. & T.....	16*	18*
Mass. E. Ry.....	18¼*	18	W. T. & T., pfd....	90¼*	91¼*
Mass. E. Ry., pfd...	85½*	86			

*Last price quoted.
Shares sold for five days, Dec. 26 to Dec. 31.

Western States Gas & Electric Company.—The purpose of the recent organization of the Western States Gas & Electric Company, referred to in our issue of Dec. 8, is to take over the California properties recently acquired by H. M. Byllesby & Company, of Chicago. These include two large water-power developments and several water-power sites not yet developed. The principal local plants purchased consist of the electric and gas properties formerly owned by the Stockton Gas & Electric Corporation, at Stockton; the electric light and power business at Richmond, and the gas and electric properties at Eureka. The American River Electric Company, which owns a large hydroelectric plant on the American River in Eldorado County and maintains a reserve steam turbine plant at Stockton, is included in the transaction. The Humboldt Gas & Electric Company, operating at Eureka, possesses a considerable water-power development in Trinity County, transmitting energy to Eureka, sixty-five miles away. The American River Electric Company's business includes service to Stockton, Placerville, Florin, Elk Grove, Sheldon, Gault, Lodi and Plymouth by means of long-distance transmission lines, which are also extensively utilized for supplying power for gold-mining and irrigation purposes. The Humboldt electric business includes service to the towns of Arcata, Alton, Ferndale, Field's Landing, Fortuna, Hydesville, Loleta and Rohnersville. Eureka and surrounding towns have a population of 22,000. They are located on Humboldt Bay, which affords one of the few good harbors on the Pacific Coast. Eureka will soon be connected with San Francisco by a railroad now under construction. Stockton, with its suburbs, has a population of 30,000, and, besides being one of the oldest cities in California, is a manufacturing center of importance. Richmond, a newer town of 12,000 people, lies on San Francisco Bay, south of Berkeley. It also is a manufacturing center and is the location of large new shops being built by the Pullman Car Company. All three cities have shown very rapid recent growth.

Commonwealth Power, Railway & Light Company.—The returns of the Commonwealth Power, Railway & Light Company, the holding concern organized a year ago by Hodenpyl, Walbridge & Co. and E. W. Clark & Co. to take over railway and light properties in Michigan, will be more favorable for the year 1910 than the best estimates made by the management. As the company has been in operation only for a year, comparisons must be made with the individual operations of the subsidiary companies in previous years. An estimate based upon the actual figures for the first ten months of the year shows gross $4,950,000, as compared with $4,350,000 for the separate companies during the previous year, and net $2,390,000, as compared with $2,105,000 in the previous year. The surplus after paying fixed charges will be $910,000, which is equal to 15.16 per cent on the outstanding preferred stock of the company. The Commonwealth Power, Railway & Light Company, while owning the stock and controlling the operation of these subsidiaries, has not issued any bonds of its own, owing to the objection of the Michigan Railroad Commission. All of the financing necessary during the year was done by the separate companies. The properties included in the combine are the developed and undeveloped water-powers on the Muskegon, Kalamazoo, Grand and Au Sable Rivers. The subsidiary companies control the electric light and power business of Grand Rapids, Saginaw, Bay City, Kalamazoo, Battle Creek, Jackson, Flint, Pontiac, Cadillac and a number of intermediate towns, and the railway business of Grand Rapids, Saginaw and Bay City. The gas business of some of these cities is also controlled. About a year ago work was commenced on a 12,000-hp hydroelectric development on the Au Sable River and the construction of transmission lines to Bay City, Saginaw and Flint. It is said that the dam has now been completed, and the installation of machinery will begin early in the new year.

Metropolitan Reorganization Plans.—The reorganization plan of the Metropolitan Street Railway Company, upon which a committee of bondholders, assisted by Stone & Webster, has been at work for many months, was presented to the Public Service Commission last week. The total present outstanding securities and obligations of the Metropolitan Street Railway system are about $136,000,000, which does not include the outstanding securities of some of the collateral companies. The new plan provides for an issue of new securities of the total amount of about $96,000,000, making a reduction of about $40,000,000. The fixed charges, representing the interest on the bonds which have been adjusted under the plan, have been reduced more than $1,000,000 per year. The plan also provides for participation on the part of the old stockholders by the payment of an assessment which is expected to furnish the new company with $10,000,000 in cash. It is said that if the Interborough-Metropolitan Company fails to meet its assessment on its stock of the Metropolitan Street Railway Company the property will probably be sold at foreclosure and will be bought in by Stone & Webster and operated by that well-known firm. The Interborough-Metropolitan has continually refused to confer with the reorganization committee and the committee has arranged with Stone & Webster to do the necessary financing in case the parent company refuses to participate.

United Properties Company.—The United Properties Company of California was incorporated Dec. 30 under the laws of Delaware with a capital stock of $200,000,000. The company is authorized to equip, construct and operate railroads, steamship lines, electric light and power plants and traction lines, provide water for domestic uses and irrigation and build and operate wharves, docks and warehouses. The operating offices will be in San Francisco and Oakland. The directors are Harry W. Davis, of Wilmington; F. M. Smith, W. S. Tevis, R. J. Hanford, Gavin McNab and W. R. Alberger, of San Francisco; C. B. Zabriskie, of New York, and Dennis Searles, of Oakland. It is said that the new corporation represents a merger of all the public utility companies of Berkeley and Oakland, including the ferry lines to San Francisco. Mr. Zabriskie is manager in New York of the Pacific Coast Borax Company, of which F. M. Smith is president. He declined to make any statement concerning the new company at the present time.

Southern Bell Telephone Bonds.—N. W. Harris & Company and Kidder, Peabody & Company are advertising for sale to the public at 96 and interest the $10,000,000 issue of the Southern Bell Telephone & Telegraph Company thirty-year first mortgage 5 per cent bonds. In the circular announcing the sale of these bonds the report of the company for 1910 (partially estimated) is stated as follows: Gross revenue, $6,000,000; operating expenses and taxes, including $1,820,000 maintenance charges, $4,300,000; net earnings, $1,700,000, leaving a surplus, after paying the interest on the new bond issue, of $1,200,000. It is stated in the circular that the territory served by the Southern Bell company includes the most rapidly growing portion of the Southern States, and that the total population served is estimated at over 12,000,000. On Oct. 31 the company was operating 14,782 miles of pole lines and had in service 250,000 miles of wire on poles and 167,000 miles of underground wire.

Third Avenue Bondholders Appeal.—The bondholders' committee of the Third Avenue Railroad Company has appealed to the Supreme Court of New York for a review of the reorganization plans which were rejected a short time ago by the Public Service Commission of the First District. The bondholders review in detail the proceedings before the commission, and show that three separate hearings, which stretched over a period of about two years, were held. The petition in their suit claims that the Public Service Commission law as construed and enforced by this commission is in violation of the constitutional rights guaranteed to the company. The ground upon which the reorganization plans were refused was that the proposed capitalization was in excess of the value of the property.

Cheap Telephone Bonds.—At the weekly auction of securities in New York, Dec. 28, 1910, $670,000 worth of 5 per cent first mortgage bonds of the National Telephone Corporation were sold for $3.350, or $5 per bond. The National Telephone Company is a West Virginia corporation and is operating at present under the control of federal receivers. John A. Howard, who recently filed a petition in bankruptcy, was the promoter of the enterprise. A recent examination of the books of the company showed that from May 7, 1909, to July 5, 1910, the company earned a net profit of $12,822 and $187,863 was charged against it.

Hood River Electric Company Sold.—The Oregon & Washington Electric Corporation, of Portland, has purchased the Hood River (Ore.) Electric Light, Power & Water Company. It is said that the price paid for this property was $70,000, the purchaser assuming the bonded indebtedness amounting to about the same amount. The Oregon & Washington Corporation has been buying a number of plants in the Far Northwest and recently secured the Vancouver Electric Light & Power Company.

American Light & Traction Company.—The report of the American Light & Traction Company for 1910 will show larger earnings for the stockholders than in any previous year. The net earnings available for dividends will be approximately $3,735,000, or 15.34 per cent better than last year. The total gross earnings for the year, with December estimated, are $3,855,000, as compared with $3,345,440 in 1909. The officials of the company state that a conservative estimate of next year's earnings would place them at least 10 per cent above those of this year. The cash in hand in the company's treasury amounts to nearly $1,500,000, and the separate companies are said to have $1,000,000 in bank. There are also temporary investments of nearly $2,000,000, all of which shows that the company is amply supplied with working capital.

Standard Gas & Electric Company.—The earnings of the subsidiary companies of the Standard Gas & Electric Company, which was organized some months ago by H. M. Byllesby & Company, for the year 1910 show liberal increase in both gross and net over the previous year. During the month of October the Fort Smith (Ark.) Light & Traction Company showed a gain of more than 17 per cent; the Tacoma (Wash.) Gas Company showed a gain of 47 per cent; the Muskogee (Okla.) Gas & Electric Company a gain of 23.8 per cent; the Ottumwa (Ia.) Railway & Light Company a gain of 11.3 per cent; the Enid (Okla.) Electric & Gas Company a gain of 24.8 per cent; Mobile Electric Company, a gain of 10.9 per cent, and the Northern States Power Company a gain of 24.4 per cent.

Massillon Electric Company.—During the twelve months which ended Nov. 30 the earnings of the Massillon (Ohio) Electric & Gas Company were equal to 3.25 per cent on the $500,000 outstanding capital stock, as compared with 2.35 per cent the year previous. The net earnings for this period were equal to three times the amount required to pay the interest on the company's outstanding bonds. This company distributes energy for light and power to the City of Massillon and the neighboring towns of Canal Fulton and Navarre. It also owns the gas system at Massillon, but this plant has not been profitably operated since natural gas came into the field. The company serves a population of about 17,500. The total station capacity is 1000 kw. Henry L. Doherty is president of the company.

United Railways Investment Company.—The earnings of the United Railways Investment Company, which controls both the United Railroads of San Francisco and the Philadelphia Company, of Pittsburgh, showed a very large increase for the year 1910. The larger percentage of increase has been shown by the United Railroads of San Francisco. Not only have the gross receipts of this company grown to a considerable extent, but the operating expenses have been reduced, owing to the fact that the supply of power costs much less than it did a year ago. This is on account of the operation of the company's hydroelectric plants on the Stanislaus River. It is expected that the Investment company will in a short time resume dividends upon its preferred stock.

Niagara Falls Power Company Stock.—The Public Service Commission of the Second District of New York having authorized the Niagara Falls Power Company to issue common stock to the amount of $1,534,000, the financial condition of the company will be very much improved. The proceeds are to be used to liquidate the 10-year 6 per cent debentures, series "A," to the amount of $614,000; 6 per cent debentures, series "B," to the amount of $815,000, and 6 per cent debentures, series "C," to the amount of $105,000. The discharge of these outstanding obligations will relieve the company of an annual fixed charge of nearly $100,000. The company's earnings for 1910 are the largest in its history, and its business is being rapidly developed.

Cities Service Company.—Officials of the Cities Service Company state that the earnings of the subsidiary companies—the Denver Gas & Electric, the Empire District Electric and the Spokane Gas & Fuel companies—show at least 25 per cent gain in 1910 over the previous year. The largest percentages of gain were in the two electrical companies. The Empire District Electric Company has recently acquired a controlling interest in the Columbus (Kan.) Electric Company. In addition to this Henry L. Doherty & Company have acquired an interest in the Citizens' Gas, Electric & Heating Company, of Mount Vernon, Ill.

Twin City Rapid Transit Company.—The November earnings of the Twin City Rapid Transit Company, of Minneapolis, showed a loss of more than $8,000 in net, in spite of the fact that the gross earnings increased almost $40,000. This difference is explained as being due to the fact that the low water in the Mississippi River increased very largely the operating expenses. The road was forced during almost the entire month to rely upon its steam station for energy. The earnings of the company for the calendar year 1910 will be the largest in its history.

American Telephone & Telegraph Company.—T. C. Kingsbury, a member of the firm of N. W. Harris & Company, became a vice-president of the American Telephone & Telegraph Company on Jan. 1.

DIVIDENDS.

Associated Gas & Electric Company, preferred, quarterly, 1½ per cent, payable Jan. 15.

Bell Telephone Company of Pennsylvania, quarterly, 1½ per cent, payable Jan. 16.

Boston Suburban Electric Companies, preferred, quarterly, 1 per cent, payable Jan. 16.

Fort Smith (Ark.) Light & Traction Company, preferred, quarterly, 1¾ per cent, payable Jan. 15.

Manchester (N. H.) Traction, Light & Power Company, quarterly, 2 per cent, payable Jan. 16.

Minneapolis General Electric Company, preferred, semi-annual, 3 per cent; common, quarterly, 1¾ per cent, both payable Feb. 1.

National Carbon Company, quarterly, common, 1½ per cent, payable Jan. 14.

Northern States Power Company, preferred, quarterly, 1¾ per cent, payable Jan. 15.

Oklahoma Gas & Electric Company, preferred, quarterly, 1¾ per cent, payable Jan. 15.

Ottawa Light & Power Company, 1½ per cent, bonus, 2 per cent, payable Jan. 10.

Ottumwa (Iowa) Railway & Light Company, preferred, quarterly, 1¾ per cent, payable Jan. 15.

San Diego Consolidated Gas & Electric Company, quarterly, preferred, 1¾ per cent, payable Jan. 15.

Springfield (Ohio) & Xenia Railway Company, preferred, quarterly, 1¼ per cent, extra, ½ per cent, payable Jan. 5.

United Metals Selling Company, quarterly, 5 per cent, payable Jan. 15.

Youngstown & Ohio River Railroad Company, preferred, quarterly, ¾ per cent, payable Jan. 5.

REPORTS OF EARNINGS.

	Gross Earnings.	Expenses.	Net Earnings.	Charges.	Surplus.
Chattanooga Railway & Light Company:					
November, 1910	$70,480	$36,326	$34,154	$24,120	$10,034
November, 1909	64,811	36,342	28,469	22,237	6,232
Cumberland Telephone & Telegraph Company:					
November, 1910	604,289	344,700	259,588	56,518	203,070
November, 1909	560,032	306,971	253,061	40,742	212,319
Detroit United Railway Company:					
November, 1910	739,982	478,304	261,678	174,312	102,308
November, 1909	676,482	440,750	235,732	157,919	88,424
Nashville Railway & Light Company:					
November, 1910	158,739	85,848	72,891	.....	.....
November, 1909	149,426	83,181	66,245	.....	.....
Philadelphia Company:					
November, 1910	1,703,422	1,002,653	700,769	.....	.....
November, 1909	1,707,016	962,894	744,122	.....	.....
Twin City Rapid Transit Company:					
November, 1910	619,149	319,732	299,417	137,912	161,504
November, 1909	580,795	273,044	307,751	140,251	167,500
United Railroads of San Francisco:					
November, 1910	633,618	350,465	283,153	.....	.....
November, 1909	619,313	352,570	266,743	.....	.....

General News

Construction News.

SAYRE, ALA.—Extensive improvements are contemplated to the property of the Sayre Mining Company, including the installation of an electric plant. The company has authorized a bond issue to the amount of $25,000 to provide funds for same.

SEWARD, ALASKA.—The Alaska Electric Company is reported to be contemplating the construction of a telephone line from Seward to the Innoko and Iditarod.

PARKER, ARIZ.—Plans are being considered by the Pacific Current Motor Company for the installation of what is known as the Price current motor on the Colorado River, at a point near Headgate Rock. The company proposes to supply water to irrigate land in this vicinity and to generate electricity to be used to operate pumps for irrigation purposes. W. H. Taggart, of Los Angeles, Cal., is secretary of the Pacific Current Motor Company.

EUREKA, CAL.—The quesion of establishing a municipal electric light plant and telephone sytem in Eureka is under consideration.

HUNTINGTON BEACH, CAL.—Preparations are being made by the Southern Pacific Railroad Company to equip its steam railroad to the Holly Sugar Company's factory for electrical operation. Representatives of the Associated Chambers of Commerce of Orange County are circulating a petition asking the Southern Pacific Company to equip its railway between Huntington Beach and Anaheim for electrical operation and to operate an interurban service between the two cities.

KERMAN, CAL.—Preparations are being made by the Vineland Telephone Company, recently incorporated, for the erection of a telephone line for the accommodation of the farmers in the Kerman district from the town to and beyond the river. The main line will be about six and a half miles long. It will have eight branches to the nearby ranches, covering ten miles or more. The company is capitalized at $25,000 and the incorporators are: J. C. Ashlin, Willfred Baker, R. S. Elliott, P. H. Carlsgard and N. O. P. Syongrounds.

MERIDIAN, CAL.—Surveys are being made by the Pacific Gas & Electric Company for the purpose of extending its transmission lines from Meridian to Colusa. When the line is completed the company will supply electricity for lamps and motors in Colusa. The company also proposes to supply electricity to the reclamation districts between Meridian and Colusa.

SAN FRANCISCO, CAL.—The Standard American Dredging Company, of San Francisco, Cal., has just placed an order with the Westinghouse Electric & Manufacturing Company, of Pittsburgh, Pa., for a 700-hp alternating-current induction motor.

SAN FRANCISCO, CAL.—Plans have been completed by Alfred I. Coffey, city architect, for the power house and laundry building of the new San Francisco Hospital, located at Twenty-third Street and Potrero Avenue. The equipment of the power house will include four steam turbo-generators. Provision will be made for an additional turbine.

SAN JACINTO, CAL.—The Ramona Power Company has purchased a reservoir site below Idyllwild. The company has secured rights for power purposes to practically all the water in the north and south forks of Strawberry Creek. The water will be piped from a point as high as possible in the canyon in order to secure a maximum fall to the power house, to be located in San Jacinto Canyon, near the foot of the mountain. After passing through the power house the water will be returned to its natural source, where the water is already owned for irrigation purposes.

SUSANVILLE, CAL.—Work is progressing rapidly on the Cady & Bunnell power plant, located on the Bunnell property, about seven miles west of Susanville. The plant when completed will supply electricity for lamps in Susanville.

PALISADE, COL.—The Town Board has agreed to grant an electric light franchise to the Mutual Light, Power & Telephone Company, provided the promoters will agree to put up a cash bond to carry out the provisions of the proposed franchise. Owing to dissatisfaction with the service of the old Palisade Light & Power Company a new company has been organized by local citizens. The old plant was taken over for $7,000 by Hendrie & Bolthoff, of Denver, Col., who have recently been operating it. H. P. Waterman, secretary of the old company, has asked the Council not to grant the new franchise, and has promised to install a new plant and furnish a twenty-four-hour service, if given time to make the necessary changes.

BRIDGEPORT, CONN.—The directors of the United Illuminating Company, which operates electric plants in Bridgeport and New Haven, Conn., have voted to advise the stockholders to take over the plant and holdings of the Fairfield Electric Light Company, of Fairfield, Conn. It is expected that the transfer will be made at the annual meeting in March. The company recently secured the property of the Stratford Light Company, which gave the company the entire field between this city and New Haven.

NEW HAVEN, CONN.—The Connecticut Company has awarded contracts to the Gillett Construction Company and the Lord & Lake Company for the construction of a brick addition to its power house on Grand Avenue, New Haven. A 400-kw generator and other electrical equipment will be installed.

WINDSOR LOCKS, CONN.—The Northern Connecticut Light & Power Company has given notice that it will apply to the next Legislature for the right to extend its transmission lines, pipes, conduits, etc., in and through the highways of Windham and Middlesex Counties; also to construct dams, power plants and electrical systems over, under or through navigable waters and for the right to take by eminent domain lands necessary or convenient for the purposes of the company. It is understood that the company proposes to supply electricity to electric light and power companies in Middlesex County.

WASHINGTON, D. C.—Bids will be received until Jan. 10 at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for furnishing at the Navy Yard, Mare Island, Cal., schedule 3170, one overhead traveling electric crane; schedule 3187, one 2-kw constant speed motor-generator and one 2-kw, open core wireless telegraph transformer.

WASHINGTON, D. C.—Bids will be received at the office of the Commissioners of the District of Columbia, Washington, D. C., until Jan. 10, for the construction of a central steam-heating plant and boiler house at the M Street, High, Simons and Douglass Schools, Washington, D. C. Form of proposal and all necesary information may be obtained from the chief clerk, Engineer Department, Room 427, District Building.

WASHINGTON, D. C.—Bids will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until Jan. 10 for furnishing at the various navy yards the following supplies:—Brooklyn, N. Y.—Schedule 3207, one set of speed gears, one set of motors with controlling appliances and one set of four distant controlling apparatus for above gears. Bids will also be received until Jan. 17 as follows: Puget Sound, Wash.—Schedule 3188, one special motor head stock speed lathe. Newport, R. I.—Schedule 3236, one air compressor set. Schedule 3232, eighteen generator sets and 200 transformers, to be delivered at the various navy yards. Norfolk, Va.—Schedule 3243, electrical helm indicators, two steering telegraph sets. Proposals will also be received until Jan. 24: Schedule 3248, to be delivered at Norfolk, Va., vacuum drying and impregnating apparatus. Norfolk Va.—Schedule 3247, one electric deck winch.

ATLANTA, GA.—It is reported that contracts are now being awarded by the Georgia Power Company, through the Northern Construction Company, of Detroit, Mich., for the development of its Tallulah Falls property, where it is proposed to develop over 50,000 hp for transmission by electricity. The work includes the construction of a dam 50 ft. high and a 12-ft. tunnel, one and one-half miles long, to convey water to power house; 150 miles of transmission lines, to be carried on steel towers, carrying a voltage of 100,000. Three units will be installed at first, consisting of 8000-kw generators driven by 14,000-hp water wheels under a 600-ft. head. The ultimate development will include six units, same as above.

ROBERTA, GA.—Bids will be received by W. J. Marshall, R. F. D., Lizell, Ga., about Jan. 30, for the construction of an electric light plant for the town of Roberta.

CHICAGO, ILL.—Sealed proposals will be received by the City of Chicago until Jan. 19, at the office of the Commissioner of Public Works City Hall, 200 East Randolph Street, Chicago, Ill., for two 20,000,000-gal. centrifugal pumps and two 1000-hp, synchronous electric motors, together with piping, wiring, switchboard and other appurtenances at the Twenty-second Street pumping station, according to plans and specifications on file in the office of the Department of Public Works, Room 705, City Hall, Chicago, Ill. Proposals must be made out on blanks furnished by the above office. B. J. Mullaney is Commissioner of Public Works.

TAMPICO, ILL.—The Village Council has adopted a resolution to notify the Dixon, Rock Falls & Southwestern Railway Company that it must equip its railway for electrical operation or discontinue operating its car in the village and tear up its tracks. The company secured a franchise to operate an electric railway through the village, but so far the motive power has been furnished by a dummy steam engine. The road extends from Tampico to Hooppole, a distance of about fifteen miles.

WATAGA, ILL.—It is reported that the Galesburg & Great Eastern Railroad Company is contemplating equipping its railroad for electrical operation and extending it into Galesburg. A. J. Harms, of Chicago, Ill., is superintendent.

BEECH GROVE, IND.—Plans are being made by the Big Four Railroad for the construction of six additional shops at its plant at Beech Grove, which will include a combined steam and electric power house. The new shops will be equipped for electric motor drive throughout.

FRANKFORT, IND.—The plant and holdings of the Central Energy Company, of Frankfort, Ind., have been taken over by the Central Union Telephone Company, of Chicago, Ill.

HENRYVILLE, IND.—An independent telephone company has been organized in Henryville for the purpose of installing a new system in this place. The Cumberland Telephone Company now operates a telephone system here.

JEFFERSONVILLE, IND.—Owing to the Cumberland Telephone Company having raised its rates, steps have been taken to organize and install an independent telephone plant in this locality. The City Council, it is said, will grant a new company a franchise.

MARION, IND.—No bids were submitted for the $50,000 bond issue offered by the City of Marion, the proceeds to be used for the construction of an electric light plant. It is understood that the validity of the bonds is questioned. The city already owns a plant for street lighting and proposes to establish a plant to supply electricity for commercial purposes. The Marion Light & Heating Company, owned by the American Gas & Electric Company, now supplies electrical service in this city.

ADAIR, IA.—At an election held Dec. 20 the citizens voted in favor of the proposition to issue $10,000 in bonds, the proceeds to be used for the construction of an electric light plant. This will make the bond issue $30,000 for the water works and electric light plant. The Council is ready to receive proposals for the service of an engineer, and to let contracts for the entire work. J. J. Hayden is town clerk.

CENTERVILLE, IA.—Plans are being considered by the Centerville Light, Power & Traction Company for rebuilding its central heating system and the installation of a new 300-hp boiler.

HAMBURG, IA.—The citizens on Dec. 12 voted to grant a franchise to E. B. Hillman, of Hamburg, Ia., a franchise to construct and operate an electric light plant in Hamburg, Ia. Frank Blunk, of Hamburg, Ia., is engineer in charge.

KEOKUK, IA.—The Keokuk Electric Railway & Power Company is reported to be preparing plans for making extensive changes to its power plant in Keokuk. A. D. Ayres, of Keokuk, is manager.

MENLO, IA.—The Farmers' Mutual Telephone Company is contemplating the erection of toll lines to Guthrie Center, Greenfield, Stuart and Casey.

REDFIELD, IA.—The installation of an electric light plant in Redfield is reported to be under consideration.

ROCK VALLEY, IA.—The local telephone exchange has been purchased by E. S. Thayer, who has also petitioned the City Council for an electric light franchise in Rock Valley.

INDEPENDENCE, KAN.—Bids will be received at the office of the Supervising Architect, Treasury Department, Washington, D. C., until Jan. 26 for the construction of United States post office, complete, including plumbing, gas piping, heating apparatus and electric conduits and wiring, in accordance with plans and specifications, copies of which may be obtained at the above office or from the custodian of site at Independence. James Knox Taylor is Supervising Architect.

MURRAY, KY.—The Murray Traction Company has begun work on the preliminary surveys for its proposed electric railway to extend from Murray to the Tennessee River, sixteen miles in length. Nathan Ryan, of Murray, is president of the company.

CROWLEY, LA.—The City Council has authorized the purchase of additional equipment for the municipal electric light plant, including one 110-hp engine, one 150-kw generator and one 75-kw generator. It is proposed to install a two-unit system and establish a twenty-four-hour service for lamps and motors.

DEXTER, MAINE.—It is reported that the Morrison Woolen Company has contracted with the Central Maine Power Company, of Dexter, Maine, to supply electricity to operate the Morrison mill on Center Street.

FARMINGTON, MAINE.—The new power plant of the Franklin Power Company, located at Cleveland Rips, on the Carrabassett River, four miles above North Anson, is completed and supplying electricity for lamps and motors in Farmington. The transmission line is seventeen miles in length. The plant has an output of 600 kw. Beginning with Jan. 1, the price of electricity will be reduced from 18 cents to 12½ cents per kw-hour.

PRESQUE ISLE, MAINE.—The Aroostook Valley Railroad Company is contemplating the construction of two extensions to its system, one to begin at Washington Station in Presque Isle and to extend across Woodland to New Sweden, and the other through Caribou to Limestone.

SALISBURY, MD.—The City Council has awarded the contract for street lighting to the Salisbury Light, Heat & Power Company for a term of three years. Under the terms of the contract the company is to furnish 16-cp incandescent lamps, with an all-night service, at the rate of 75 cents per lamp per month and arc lamps at $5 each per month, which is the same price the city is paying under the present contract.

BOSTON, MASS.—Orders have recently been placed by the Boston Elevated Railway, of Boston, Mass., with the Westinghouse Machine Company, of Pittsburgh, Pa., for seven stokers to replace some old equipment at its Charleston and Lincoln Wharf stations.

BURLINGTON, P. O. WOBURN, MASS.—The citizens have voted to enter into a contract with the Edison Electric Illuminating Company, of Boston, Mass., for the installation of twenty-five street lamps.

LEOMINSTER, MASS.—The Selectmen and lighting committee have decided to change the present street arc lamps to tungsten lamps for street lighting. It is proposed to install 80-cp and 60-cp tungsten lamps and to enter into a new contract with the Leominster Electric Light & Power Company for lighting the streets of the town. Under the present contract the town pays $105 each per year for arc lamps with an all-night service and $75 per lamp per year for lamps burning until 1 o'clock.

LEOMINSTER, MASS.—The Leominster Electric Light & Power Company has announced a reduction in the price of electricity for lamps and motors, taking effect from Jan. 1, 1911. Under the new schedule the rate is reduced from 16 cents to 15 cents per kw-hour for the first 50 kw consumed each month and 12 cents per kw-hour for all used in excess of that amount. The price for electricity for motors has been reduced to 5 cents per kw-hour for the first 2000 kw consumed per month, and all in excess of that amount 2½ cents per kw-hour.

WORCESTER, MASS.—Mayor James Logan, of Worcester, has filed with the State Board of Gas and Electric Light Commissioners a formal complaint against the Worcester Electric Light Company, alleging exorbitant prices. He states that the company has refused to furnish the city with arc lamps for less than $86.25 each per year, which he believes is an exorbitant price.

IRONWOOD, MICH.—The Gogebic & Iron Counties Railway & Light Company has filed amendments to its charter increasing its capital stock from $100,000 to $700,000. The company is negotiating with the Twin City General Electric Company with a view of taking over the plant and holdings of the last-named company.

LANSING, MICH.—The Au Sable Electric Power Company has applied to the State Railroad Commission for permission to issue $450,000 in bonds, the proceeds to be used for the erection of an electric transmission line from its power plant on the Au Sable River to Saginaw, Flint, Owosso, Lansing and other cities of central Michigan.

MOUNT CLEMENS, MICH.—Bids will be received at the office of the Supervising Architect, Treasury Department, Washington, D. C., until Feb. 6, 1911, for the construction, including plumbing, gas piping, heating apparatus, electric conduits and wiring, of the United States post office at Mount Clemens, Mich., in accordance with drawings and specifications, copies of which may be obtained from the custodian of site at Mount Clemens, Mich., or at the above office. James Knox Taylor is Supervising Architect.

BRAHAM, MINN.—The Eastern Minnesota Power Company, of Pine City, Minn., has submitted a proposition to the citizens of Braham, asking them to subscribe to $5,000 in capital stock of the company and to install electric lamps. The company agrees to furnish and maintain twenty-five street lamps, with an all-night service, for $50 per month.

BRAINERD, MINN.—Work has commenced on the construction of the new electric plant, which is being erected by the Toltz Engineering Company, of St. Paul, Minn. It is expected to have plant in operation by March. Under the arrangements with the City of Brainerd the Toltz Engineering Company will supply electricity at the switchboard of the municipal electric plant. The city will continue to own and operate the distributing system. Since the municipal plant was burned out last April energy has been supplied from the railway shops of the Northern Pacific Railroad Company.

FERGUS FALLS, MINN.—The Edwards Telephone Company, recently organized, proposes to erect a telephone system in the Town of Friberg and adjoining townships in the central part of this county. August Splisgerber is president of the company and E. M. Nelson is secretary.

SHAKOPEE, MINN.—Plans are being prepared by the superintendent of the municipal electric light plant for the installation of an engine-driven pump in the power house, bids for which will be received until Jan. 10.

WORTHINGTON, MINN.—Plans are being considered for the construction of an electric railway to connect Albert Lea and Worthington, via Elmore, Blue Earth, East Chain, Fairmont and along the southern edge of Minnesota and northern Iowa. G. E. Doyle, of East Chain, and H. W. Knight, of Chicago, Ill., are interested in the project.

MARYVILLE, MO.—Plans are being prepared by the Missouri & Kansas Telephone Company for extensive improvements to its plant in Maryville, which will involve an expenditure of about $40,000.

WARSAW, MO.—S. O. Norris, of the Continental Power & Development Company, of Clinton, Mo., is reported to have purchased the Arnolds mill property and proposes to supply electricity for lamps and motors in Warsaw. It is understood that power for operating the plant will be secured from the Niangua River.

ORLEANS, NEB.—The power house of the Orleans Electric Light & Power Company was badly damaged by an explosion on Dec. 18. Work on reconstruction of the plant will begin immediately.

MASON, NEV.—Negotiations are under way between Jules Labararthe, general manager of the Mason Valley Mines Company and the Truckee River General Electric Company whereby the last-named company will supply electricity to operate the mines of the Mason Valley Mines Company. Under the terms of the contract the Truckee River General Electric Company is to erect a new steel tower transmission line from its power plant at Virginia City to the smelter site, which will give the smelting company service from two independent sources, the site now being connected with the Yerrington transmission line.

RENO, NEV.—Plans have been completed by the Truckee River General Electric Company for the construction of a new power plant near Verdi. The work will include the construction of a large dam across the Truckee River, and the erection of a power house, near Verdi, where about 3000 hp will be developed. Electricity generated at this plant will be used for the smelter at Mason City and Waubuska and also for the operation of mines at Yerington.

GIBBSBORO, N. J.—The installation of a municipal electric light plant in Gibbsboro is reported to be under consideration.

HARRISON, N. J.—The Town Council is considering the question of changing the street lighting system on Harrison Avenue. It is proposed to erect arches across the street at a distance of every 100 ft., and to place twelve Madga lamps on each arch. The system may also be erected along the turnpike road to the Hackensack Bridge, through Kearny, the arches to be erected every 200 ft.

MORRISTOWN, N. J.—The Pine Brook Electric Railroad Company has applied for a franchise to construct and operate an electric railway in Bloomfield Avenue, near Boonton.

CLOVIS, N. M.—Plans are being considered by W. D. McBee, of Clovis, and associates for the construction of an electric power plant and erection of a system of transmission lines to the farms in the vicinity of Melrose, N. M., to supply electricity to operate irrigating pumping plants. It is proposed to install motors and pumps at the different wells from which water is obtained. It is proposed to reclaim about 12,000 acres. The cost of the work is estimated at about $300,000.

SILVER CITY, N. M.—The Gila River Power Company has filed application with the Territorial Engineer for water in Gila River in the western part of Grant County. The company expects to develop about 15,000 hp.

BUFFALO, N. Y.—Plans have been completed for the construction and equipment of a power house for the International Bridge Company at Niagara Street and the Erie Canal, near the bridge entrance.

BUFFALO, N. Y.—The Niagara Gorge Railroad Company has recently installed a small substation in Lewiston, the equipment of which consists of a 300-kw General Electric rotary converter with two transformers.

BUFFALO, N. Y.—The Aldermanic Lamp Committee has entered into a new agreement with the Buffalo General Electric Company to supply electricity for lighting the city buildings at a flat rate of 4½ cents per kw-hour. The old rate was 6 cents. In school buildings where electricity is used to operate moving picture exhibits the price will be 9 cents per kw-hour.

MONROE, N. Y.—The Livingston-Niagara Power Company is reported to have been granted permission to exercise its franchises in the towns of Avon, Caledonia, Geneseo, Lima and York in Livingston County, and in the towns of Rush Mendon and Wheatland, in Monroe County. It is expected that the Lima-Honeoy Falls Trolley Company, which has recently changed hands, will come under the control of the new company.

NEW YORK, N. Y.—Bids will be received until Jan. 10 by Kingsley L. Martin, Commissioner of Bridges, for constructing elevator, stairs, drainage, ornamental and electrical work for the anchor piers of the Queensboro Bridge over the East River.

NEW YORK, N. Y.—Frederick W. Whittridge, receiver of the Forty-second Street, Manhattanville & St. Nicholas Avenue Railway Company, has applied to the Public Service Commission, First District, for permission to change the motive power on the 110th Street crosstown line to storage battery power.

ROME, N. Y.—The Board of Public Works has awarded the contract for lighting the streets of the city for a term of five years to the Rome Electric Light & Power Company at $83 per arc lamp per year. Under the present contract the city pays $90 per lamp per year.

WILSON, N. Y.—The Ontario Railway Company, recently incorporated, is reported to have submitted a proposition to the Village Board of Trustees offering to build an electric railway from the village of Wilson to the Rome, Watertown & Ogdensburg Railroad, a distance of two miles.

BLACK MOUNTAIN, N. C.—C. E. Waddell, of Asheville, N. C., engineer, is reported to have been engaged by the Blue Ridge Association for Christian Conference to take charge of the construction of electric light plant, water works and grounds in connection with the erection of a summer school to be established by the association.

WINSTON-SALEM, N. C.—Plans are being made by the P. H. Hanes Knitting Company for the installation of 8600 spindles in its soft-yarn mill. The mill will be operated by electricity and will require about 400 hp.

MINOT, N. D.—Announcement has been made that the plant and holdings of the Minot Light & Telephone Company have been purchased by H. M. Byllesby & Company, of Chicago, Ill. The new owners will take over the plant Jan. 20, 1911.

OAKES, N. D.—The Council is considering a proposition submitted by E. Marshall, of St. Paul, Minn., and E. M. Pope, of Watertown, S. D., for the installation of an electric light plant in Oakes.

STANLEY, N. D.—Application has been made to the Council, by John I. Moore, Minot, N. D., for a franchise to install an electric light plant in Stanley.

ALLIANCE, OHIO.—The Alliance-Akron Railroad Company has awarded the contract for grading its proposed electric railway between Alliance and Akron, a distance of twenty-six miles, to the McGinty Construction Company. Charles Keith is president.

COLUMBUS, OHIO.—Plans are being considered for the construction of a conduit to hold the wires owned by the State and the city. It is proposed to build a conduit from the prison on West Spring Street, east of Front Street, south to Broad, where it will be branched to the State institutions east and west of the river. It is proposed to supply electricity to the different State institutions from the power plant now being constructed at the Ohio Penitentiary. The State House will be the first to be connected.

GALLIPOLIS, OHIO.—The Kanauga Traction Company is planning to extend its railway to Addison in the spring. J. S. Howard is secretary.

HURON, OHIO.—The capital stock of the Huron Telephone Company has been increased from $10,000 to $40,000.

IRONTON, OHIO.—The capital stock of the Home Telephone Company has been increased from $50,000 to $120,000, the proceeds to be used to take over the plant of the Bell Company, in Ironton.

KENTON, OHIO.—The Kenton Gas & Electric Company has applied to the City Council for an extension of its franchise. In case the franchise is extended it is understood that the company will build a new plant at once, at a cost of $65,000.

LANCASTER, OHIO.—The contract for furnishing and installing additional compressor piping, etc., for light, heat and power plant at the Boys' Industrial School, Lancaster, Ohio, was awarded to the Laidlaw-Dun-Gordon Company, of Cincinnati, Ohio. F. C. Gerlach is superintendent.

ST. MARY'S, OHIO.—The St. Mary's Machine Company is reported to have secured the contract to install a gas-producing plant at the electric light plant, to cost about $18,500.

CANYON CITY, ORE.—Arrangements are being made by the Eastern Oregon Light & Power Company, of Baker City, Ore., for the installation of a power plant at Magoon Lake to furnish electricity for lamps and motors in the John Day Valley. W. C. Parrish, of Baker City, is superintendent of the company. The company also proposes to furnish electricity for operating pumps to supply water for irrigation purposes in Harney County.

FREEWATER, ORE.—The Pacific Power & Light Company is reported to be contemplating the erection of an electric transmission line to Gardena, a distance of about eight miles.

KLAMATH FALLS, ORE.—A movement has been started by George B. Frank, a local contractor, toward the establishment of a municipal electric light plant in Klamath Falls, Ore.

PORTLAND, ORE.—The Portland Railway, Light & Power Company has placed its new east side power station, known as station L, in operation. The plant has an output of 2720 hp. A 200-kw direct-current generator will be installed in the power house next spring.

PANAMA.—Sealed proposals will be received at the office of the general purchasing officer, Isthmian Canal Commission, Washington, D. C., until Feb. 25, 1911, for furnishing machines, motors and limit switches to operate the Stoney Gate valves and cylindrical locks at Gatun, Pedro Miguel and Miraflores. Blanks and general information relating to circular (No. 614), may be obtained from the above office or at the office of the assistant purchasing agents, 24 State Street, New York, N. Y.; 55 National Realty Building, New Orleans, La., and 1086 North Point Street, San Francisco, Cal. Captain F. C. Boggs is general purchasing officer.

LANCASTER, PA.—Sealed proposals will be received by the water committee at the office of the City Controller, City Hall, Lancaster, Pa., until Jan. 17, for an electrically driven centrifugal pump having a capacity of 10,000,000 gal. in twenty-four hours. Plans and specifications can be secured at the office of the superintendent of water works, Lancaster, Pa., for which a deposit of five dollars will be required. J. H. Rathfon is city controller.

POTTSTOWN, PA.—The Suburban Gas & Electric Company, of Pottstown, Pa., has recently ordered from the Westinghouse Machine Company, of Pittsburgh, Pa., one 625-kw high-pressure turbine, operating between 150 lb. steam pressure and a 28-in. vacuum. The Westinghouse Electric & Manufacturing Company will furnish a 2300-volt, 3-phase, 60-cycle, alternating-current generator to go with the turbine. The new equipment will supply electricity for light and power service.

SHICKSHINNY, PA.—Bids will be received by the borough of Shickshinny until January 10 for the installation of steam and electrical apparatus in connection with the proposed improvements to the municipal electric light plant. Specifications may be obtained upon application to the Borough Council, Shickshinny, Pa., or to Edgar Llewellyn, Pa., electrical engineer.

HOWARD, R. I.—Bids will be received until Jan. 9 by Charles Potter, secretary of Board of Charities and Corrections, for the installation of an electrical and plumbing system in the Reception Hospital, now under construction on the State Farm, Howard, R. I. Plans and specifications may be obtained from Martin & Hall, architects, 806 Union Trust Company, Providence, R. I.

CHARLESTON, S. C.—Bids will be received at the office of the Supervising Architect, Treasury Department, Washington, D. C., until Jan. 13, for a conduit and wiring system and extension of present gas piping system at the United States custom house at Charleston, S. C., in

accordance with plans and specifications, copies of which may be secured at the above office or at the office of the custodian of the building

DALLAS, S. D.—Arrangements are being made to form a company for the purpose of establishing an electric light plant in Dallas. The local business men have subscribed $6,250 toward the project. For further information address the secretary of the Boosters' Club.

ETOWAH, TENN.—T. F. Peck, secretary and general manager of the company that proposes to erect an electric light and power plant in Etowah, writes that bids for the construction of the proposed plant will be called for about April 1, 1911. The cost of the work is estimated at about $50,000.

OCOEE, TENN.—The Ocoee Construction Company, of Ocoee, Tenn., has placed an order with the Westinghouse Electric & Manufacturing Company, of Pittsburgh, Pa., for four 3750-kva, 2300-volt, 3-phase, 60-cycle, 360-r.p.m. water-wheel type generators; four 3750-kva, 3-phase, oil-insulated water-cooled transformers; two 120-kw motor-generator sets and a fourteen-panel switchboard. The water wheels will be furnished by S. Morgan Smith Company, of York, Pa., and will have a maximum capacity of 5400 hp each. Electricity generated at the plant will be used to operate electric railways in and near Chattanooga. J. G. White & Company, of New York, N. Y., have charge of the engineering work.

AUSTIN, TEX.—Announcement has been made that the Southwestern Telephone Company will make extensive improvements and extensions in Texas and Arkansas during the next two years, which will involve an expenditure of about $3,000,000. A line will be built to Brownsville. J. E. Farnsworth is general manager of the Southwestern Telephone Company.

FORT STOCKTON, TEX.—Arrangements are being made by Clay Brothers, of San Angelo, Tex., for the installation of an electric light plant and ice factory in Fort Stockton. They were recently granted a ten-year franchise by the Pecos County Commissioners.

GEORGETOWN, TEX.—The City Council is reported to have engaged F. H. Lancasshire, of Dallas, Tex., to prepare plans and specifications and as consulting engineer in connection with the reconstruction of the old plant of the Georgetown Water, Light & Power Company, for which bonds to the amount of $45,000 were recently voted for the purchase of the plant and reconstructing the same. R. E. Ward is Mayor.

HOUSTON, TEX.—Plans have been prepared by the Home Telephone Company for the erection of a telephone exchange building at Carolina Street and Rusk Avenue, to cost $30,000; the new equipment to be installed in the building will cost about $170,000.

PARIS, TEX.—F. H. Lancashire, of Dallas, Tex., has been engaged by the City Council to make investigations and make a detailed report in regard to improvements to the water pumping station and the construction of a municipal street lighting. E. H. McQuiston is Mayor.

ROCKPORT, TEX.—Plans are being made by the Rockport & Aransas Pass Railway Company, recently organized, for the construction of an interurban railway between Rockport and Aransas Pass. Electric or gasoline motors will be used. Charles F. Hoff, R. W. Newberry, S. A. Clevenger and Charles G. Johnson, of Rockport, are interested in the project.

SALT LAKE CITY, UTAH.—Proposals will be received at the office of the Supervising Architect, Treasury Department, Washington, D. C., until Feb. 3, 1911, for the extension, remodeling, including plumbing, gas-piping, heating apparatus, electric conduits and wiring system, of the United States post office and court house at Salt Lake City, Utah, in accordance with plans and specifications, copies of which may be obtained from the custodian at Salt Lake City, or at the above office. James Knox Taylor is Supervising Architect.

BRATTLEBORO, VT.—At an election held Dec. 28 the citizens voted to authorize the town officials to enter into a contract with the Twin State Gas & Electric Company for a term of ten years. The proposition to install a municipal electric plant was defeated.

BLACKWOOD, VA.—Preparations are being made by the Blackwood Coal & Coke Company for extensive property development in the vicinity of Blackwood. The company will install mining and timber-cutting machinery, including a large band mill, power equipment, etc.

CAMAS, WASH.—Application has been made to the City Council by E. E. Goff, of Portland, Ore., for an electric light franchise in Camas, Wash. If the franchise is granted Mr. Goff proposes to establish a 500-hp power plant on the Washougal River, where a power site has already been secured.

PROSSER, WASH.—The Klickitat Irrigation & Power Company is reported to have applied to the Secretary of the Interior for approval of the Horse Heaven and Glade irrigation projects. The company proposes to utilize the water from the Big Klickitat River by the construction of a large reservoir, having a capacity of 240,000 acre ft. of water, to supply water to irrigate about 300,000 acres. The company also proposes to construct a large hydroelectric power plant to supply electricity to operate the pumps to pump additional water from the Columbia River. The cost of the entire project is estimated at about $12,000,000. L. M. Price is chief engineer, and J. B. Early head of the contract department.

BRISTOL, WIS.—The Bristol Telephone Company has filed an amendment to its charter increasing its capital stock from $8,000 to $16,000.

EAST TROY, WIS.—The Milwaukee Electric Railway & Light Company has submitted a proposition to the Village Board to install an electric light system in East Troy.

WYOCENA, WIS.—The Columbia County Light & Power Company, which recently purchased the plant and holdings of the Duck Creek Light & Power Company, of Wyocena, Wis., has entered into a contract to supply electricity in Rio. The Columbia County company will make improvements to its plant, including the installation of new machinery and erect transmission lines to Rio and Pardeeville. When the proposed improvements are completed the company will establish a twenty-four-hour service in Wyocena, Pardeeville and Rio. B. C. Keeley, manager of the Duck Creek Light & Power Company, will be manager of the new company, with an office in Pardeeville, Wis.

UPTON, WYO.—Preliminary plans are being prepared by Burns & McDonnell, of Kansas City, Mo., for an electric light plant and water works system for Upton, Wyo.

CORNWALL, ONT., CAN.—The construction of an electric railway between Hawkesbury and Cornwall is reported to be under consideration. Messrs. Moloney and P. F. Campbell are interested in the project.

HAMILTON, ONT., CAN.—It is reported that the Hamilton, Caledonia & Port Dover Electric Railway Company is contemplating the construction of a power house at Caledonia. George L. Staunton, of Hamilton, Ont., Can., is interested in the company.

HAMILTON, ONT., CAN.—Announcement has been made by the Imperial Traction Company, which is applying for a federal charter, that it proposes to begin work on construction of its proposed electric railway in the spring. The company proposes to build a network of railways covering western Ontario, to connect Hamilton, Guelph, Berlin, Stratford, St. Marys and London. It is also proposed to build branch lines to Niagara Falls and Sarnia. The capital stock of the company is placed at $6,000,000. The directors are: L. B. Howland, of Toronto, Ont.; Roger Miller, of Ingersoll; George M. Reid, of London, and S. W. Hay, of Listowel.

KINGSTON, ONT., CAN.—At a meeting of representatives of nine municipalities along the frontier between Napanee and Cornwall, held at Brockville, a union of municipalities was formed for the purpose of co-operating to secure power from the Hydro-Electric Power Commission for eastern Ontario. The towns represented above are Kingston, Napanee, Brockville, Athens, Lyn, Prescott, Cardinal, Iroquois and Morrisburg. It is estimated that about 53000 hp could be used by the municipalities represented.

REGINA, SASK., CAN.—Bids will be received until Jan. 17 by A. J. McPherson, City Commissioner, for furnishing and installing the following equipment: One 1500-kw steam turbo-generator set; one 500-kw, direct-current generating unit; one 500-hp boiler; economizer, hand-power traveling crane and a coal and ash conveyor. E. W. Bull is city electrician.

ANGUSTURA, SONORA, MEX.—Surveys are being made by the Richardson Construction Company for a large irrigation system in the valley of the Yaqui River, near Angustura, for irrigating about 500,000 acres of land owned by the Yaqui River Land & Irrigation Company. The system involves the construction of a reinforced-concrete dam, 180 ft. high, near Angustura. A large hydroelectric power plant will be installed in connection with the irrigation system. The cost of the entire work is estimated at $4,500,000.

OCAMPO, CHIHUAHUA, MEX.—H. C. Flipper, of El Paso, representing the Sierra Mining Company, has been granted a concession by the State of Chihuahua, for the installation of a hydroelectric power plant near Ocampo. The proposed plant will supply electricity for operating the machinery of the mining camps of the Sierra Mining Company.

New Industrial Companies.

THE COON'S DE MARVEL COMPANY OF NEW YORK, of Rochester, N. Y., has been granted a charter with a capital stock of $100,000. The company proposes to manufacture electrical massage apparatus, etc. The incorporaters are: W. H. Coon, N. L. Coon and K. A. Holmes, all of Rochester, N. Y.

DEWEY & COMPANY, of Plano, Ill., have filed articles of incorporation, with a capital stock of $5,000, for the purpose of dealing in automobile electrical goods, vehicles, etc. The incorporators are: H. M. Dewey, E. E. Gray and B. A. Kinney.

THE DOUBLE TURBINE COMPANY, of Boston, Mass., has been incorporated by Charles L. Purinton, Emma E. Mullen and Thomas C. Murphy. The company is capitalized at $50,000 and proposes to manufacture and deal in electrical machinery.

THE INTERNATIONAL CONTRACTING COMPANY, of Winnipeg, Man., Can., has been chartered with a capital stock of $50,000,000 by Robert L. Miller, E. W. Peters, S. H. Green, E. R. Chapman and M. T. Hunter, all of Winnipeg.

THE JACOBSON ENGINEERING COMPANY, of Saratoga Springs, N. Y., has been incorporated with a capital stock of $10,000 by Charles Jacobson, John E. Jacobson and James Bloomingdale, all of Saratoga Springs, N. Y.

THE P. J. O'ROURKE ELECTRICAL ENGINEERING COMPANY, of Brooklyn, N. Y., has filed articles of incorporation with a capital stock of $25,000 for the purpose of manufacturing and dealing in electrical machinery. The incorporators are: P. J. O'Rourke, B. C. King and J. C. Totten, of Brooklyn, N. Y.

THE POST-BROWN ELECTRICAL MANUFACTURING COMPANY, of Los Angeles, Cal., has been incorporated by F. W. Post, E. A. Brown and A. K. Martell. The company is capitalized at $50,000.

THE PURE CARBON COMPANY, of Wellsville, N. Y., has been chartered with a capital stock of $100,000 by C. A. Farnum, W. J. Richardson, of Wellsville, N. Y., and R. A. Dempsey, of Bradford, Pa. The company proposes to manufacture carbon articles, etc.

THE RED CROSS GERM-PROOF TELEPHONE GLASS MOUTHPIECE COMPANY, of San Francisco, Cal., has been incorporated, with a capital stock of $500,000, by M. M. Morris, G. W. Merrill, H. H. Davis, G. E. Murphy and Maurice Summerfield.

THE SIERRA INCANDESCENT LAMP COMPANY, of Los Angeles, Cal., has been incorporated with a capital stock of $50,000. The directors are: W. H. Taylor, E. H. Fosdick and C. A. Barhydt.

THE WOODS ELECTRIC CAR COMPANY, of Los Angeles, Cal., has filed articles of incorporation with a capital stock of $10,000. The incorporators are R. S. Fend, E. D. Rogers and F. W. Plastine.

New Incorporations.

DAISY, KY.—The Daisy Telephone Company has been formed by Charles Franck, R. H. Madden and others. The company proposes to erect a telephone system throughout the county.

AKRON, OHIO.—The Brewster Telephone Company has been chartered, with a capital stock of $5,000, by B. T. Calaway, C. P. Bradford, Clay McClurg and W. H. Keller, all of Akron. The headquarters of the company are located at Brewster, Ohio, not a post office.

CANNELVILLE, OHIO.—The Cannelville Telephone Company has filed articles of incorporation with a capital stock of $10,000. The incorporators are: W. S. Pletcher, Allen Neal, W. W. Baughman and others. The company has recently purchased the Cannelville telephone exchange.

PHILO, OHIO.—The Connellville Telephone Company has been incorporated with a capital stock of $10,000 by John H. Swingle and others.

CADDO, OKLA.—The Caddo Power Company has filed articles of incorporation with a capital stock of $6,000. The incorporators are J. D. Hartzog, D. M. Wilson and P. C. Tarver.

MANGUM, OKLA.—Articles of incorporation have been filed for the Mangum Electric Company with a capital stock of $200,000 by E. S. Bessy, L. Rutherford, of Oklahoma City, Okla., and John C. Keys, of Cleveland, Ohio.

WESTON, ORE.—The Weston Mountain Telephone Company has been incorporated with a capital stock of $2,500 by Charles M. Schneider, Lester C. Leach and Alvin S. Burrill.

CLEARFIELD, PA.—The Greene Heat, Light & Power Company has been granted a charter with a capital stock of $10,000. The directors are: A. J. Musser, of Clearfield, Pa., treasurer; John S. Fisher, of Indiana, Pa.; R. A. Shillingford, Asbury W. Lee and Howard J. Thompson, all of Clearfield, Pa.

HARLEYSVILLE, PA.—The Douglasville Telephone Company has been chartered, with a capital stock of $5,000. The company will operate a telephone in Douglas Township, with Sassamansville as the main place of business. Owen K. Schultz, of Barto, is treasurer.

HARRISBURG, PA.—Three new electric light companies have been granted charters by the Secretary of State as follows: The Lower Providence Electric Company, the Plymouth Electric Company, the West Norristown Electric Company. Each company is capitalized at $5,000 and the directors are: Herbert H. Ganser, of Norristown, Pa., treasurer; Daniel A. Bertolette and Montgomery Evans, all of Norristown, Pa.

HARRISBURG, PA.—Charters have been granted by the Secretary of State to ten new companies as follows: The Edison Electric Company of Heidelberg; the Edison Electric Company of Hamburg; the Edison Electric Company of Womelsdorf; the Marion Township Electric Company; the Lower Heidelberg Township Electric Company; the Perry Township Electric Company; the Spring Township Electric Company; the West Reading Electric Company; the Wyomissing Electric Company; the Windsor Township Electric Company. Each company is capitalized at $5,000, and the directors are: George L. Roller, of Reading, Pa., treasurer; Walter A. Rigg and Harry H. Reigel, both of Reading, Pa.

HAZLETON, PA.—The Hazleton Power Company has been incorporated with a capital stock of $5,000. The directors are: A. B. Markle, C. B. Houch and C. J. Kirschner, all of Hazleton, Pa.

HAZLETON, PA.—Articles of incorporation have been filed for the Sugar Loaf Power Company with a capital stock of $5,000. The directors are: A. Markle, C. B. Houch and W. H. Lawall, all of Hazleton, Pa.

HAZLETON, PA.—The Butler Power Company has been chartered with a capital stock of $5,000. The directors are: C. J. Kirschner, of Hazleton, Pa., treasurer; A. Markle, C. B. Houck, and A. F. Harger, all of Hazleton, Pa.

HAZLETON, PA.—A charter has been granted to the Foster Power Company by the Secretary of State. The company is capitalized at $5,000 and the directors are: C. J. Kirschner, of Hazleton, Pa., treasurer; A. Markle, C. B. Houch and A. F. Harger, all of Hazleton, Pa.

PROSPECT, PA.—The Prospect Telephone Company has been granted a charter with a capital stock of $8,000. The incorporators are: Elmer Wehr, of Prospect, Pa., treasurer; J. G. Glenn, A. Bowers, and F. P. Critchlon, of Prospect, Pa.

BUMPUS MILLS, TENN.—The State Line Telephone Company has filed articles of incorporation with a capital stock of $5,000 to construct a telephone line from Bumpus Mills to Cadiz, Ky. The incorporators are: W. B. Pugh, D. Hargis, C. R. Crow and Edison T. Fentress.

FARWELL, TEX.—The Rock Island, Texico, Farwell & Southern Railway Company has been chartered with a capital stock of $200,000 to construct a seventy-five mile steam or electric railway from Farwell to a point on the south line of Cochran County, about five miles east of New Mexico. The incorporators are: M. T. Healy, S. H. Witten, D. A. Lurthicum, all of Farwell, Tex.; J. W. Shilders, K. K. Runnels, T. B. Martin and Thomas J. Allens, all of Texico, N. M.

CRIGLERSVILLE, VA.—Articles of incorporation have been filed for the Criglersville Mutual Telephone Company with a capital stock of $5,000. The officers are: W. A. Renalds, president; C. F. Ross, vice-president, both of Criglersville, and L. W. Crigler, of Madison, secretary.

BLOOMER, WIS.—The Bloomer Electric Light & Power Company has been incorporated with a capital stock of $25,000 for the purpose of supplying this village with electricity for lamps and motors.

MISHICOT, WIS.—The Mishicot Telephone Company has been chartered with a capital stock of $2,600 by A. Hoist, August Rhode, P. Bomiller and others.

OSLO, WIS.—The Oslo Power & Light Company has been incorporated with a capital stock of $5,000 by A. O. Anderson, L. O. Larsen and Mabel F. Anderson. The company proposes to develop the water power at Oslo Falls. Post office address is Oslo, R. F. D., Cato, Wis.

GRAND FALLS, N. B., CAN.—The Grand Falls Power Company has been incorporated by Sir William Van Horne, H. S. Holt, president of the Royal Bank of Canada; George F. Underwood, vice-president of the International Paper Company, of New York, N. Y., and others. The company proposes to develop the water power of the Grand Falls.

HAMILTON, ONT., CAN.—The Imperial Traction Company has filed articles of incorporation for the purpose of constructing and operating an electric railway from Hamilton, extending through Guelph, Berlin, Stratford, St. Mary's, London, Ingersoll, Woodstock, Brantford and back to Hamilton, with branches to Niagara Falls and Sarnia.

TORONTO, ONT., CAN.—The Central Canada Power Company has filed articles of incorporation, with a capital stock of $10,000,000. R. H. Parmenter, A. J. Thomson, W. S. Moloch and N. B. Wormwith, of Toronto, Ont., Can., are reported to be interested in the company.

MONTREAL, QUE., CAN.—The National Hydroelectric Company has been incorporated, with a capital stock of $10,000,000.

Personal.

MR. M. E. TERBUSH, formerly with the contract department of the Commonwealth Edison Company, Chicago, is now in charge of the new-business department of the central station company in Wilmington, Del.

MR. LOUIS R. ABEL, 258 Broadway, N. Y., has accepted the position of resident engineer of the Water Power Electric Company, which has commenced the erection of a hydroelectric plant on the Catawba River at Hickory, N. C.

COL. M. E. THORNTON, of Hickory, N. C., is on a visit to New York in the interest of the Water Power Electric Company, which has started work on the construction of its hydroelectric plant on the Catawba River at Hickory.

MR. ROBERT D. FERGUSON, until recently connected with the contract department of the Commonwealth Edison Company, Chicago, has resigned to accept the position of new-business agent of the Evansville Gas & Electric Company, Evansville, Ind. Mr. Ferguson was popular with his associates in Chicago, and before his departure a dinner was tendered to him by a number of his friends.

MR. EDWARD N. LAKE, for several years division engineer with the Board of Supervising Engineers, Chicago Traction, has resigned to accept a position as designing engineer with the Stone & Webster Engineering Corporation of Boston. The latter, as already noted in this journal, will design and erect a 30,000-kw generating and distributing system for the Boston Elevated Railway Company, and no doubt Mr. Lake will have something to do with this work.

MR. CLIFFORD S. MACCALLA, who has been with the Washington Water Power Company, Spokane, Wash., for the past seven years, has been appointed general manager, to succeed Mr. D. L. Huntington, who retains the presidency of the company. Mr. MacCalla was in charge of the construction of the Post Falls dam, a generating station, the steam relay station in Spokane and the Little Falls dam and generating station. He will assume charge of the construction of a hydraulic installation five miles above Little Falls.

Obituary.

WILLIAM DE FOREST BROWN, secretary and treasurer of the National India Rubber Company, of Bristol, R. I., lost his life by drowning while out duck shooting on Dec. 9. His canoe capsized, and the heavy clothing he wore prevented his saving himself by swimming. Mr. Brown was born in Rehoboth, Mass., and spent almost his entire life in connection with the rubber-covered wire industry. For the past eighteen years he had been secretary of the National India Rubber Company, and six years ago he was also elected to the office of treasurer, succeeding Colonel Samuel P. Colt. Mr. Brown is survived by a widow and a grown daughter. A public funeral was held Dec. 12 in the Congregational Church at Rehoboth, after private services at the Brown home in Bristol.

MR. EDWIN J. JENNESS, general foreman for the Western Electric Company at the Hawthorne Works, Chicago, died in Phoenix, Ariz., on Dec. 28. Mr. Jenness had been ill for some time and he left Chicago last February in the hope of benefiting his health. He was born in Rye Branch, N. H., in 1865, and had been connected with the Western Electric Company for twenty years. He had charge of several departments at Hawthorne and was held in high esteem by his associates. He invented a number of improvements in shop practice, and owing to his executive and technical ability was considered one of the most valuable men employed by the company in the manufacturing end of its large business. Mr. Jenness, who was unmarried, was an associate member of the American Institute of Electrical Engineers.

Trade Publications.

BELTED ENGINES.—The Allis-Chalmers Company, Milwaukee, Wis., has issued Bulletin No. 1501 dealing with the Allis-Chalmers Reliance type of belted Corliss engine.

WATT-HOUR METERS FOR SWITCHBOARD SERVICE.—The General Electric Company has issued a new edition of its Bulletin No. 4662-A on watt-hour meters for switchboard service.

THE 1200-VOLT DIRECT-CURRENT RAILWAY.—Bulletin No. 4794, issued by the General Electric Company, describes the 1200-volt lines of the Milwaukee Electric Railway & Light Company.

CARBON DIOXIDE RECORDERS.—The Precision Instrument Company, 49 Larned Street, W., Detroit, Mich., has issued an illustrated leaflet devoted to the Simmance-Abady carbon dioxide recorder, which is equipped with a sixty-day chart.

INCANDESCENT LAMPS.—The Franklin Electric Manufacturing Company, Hartford, Conn., is distributing mailing folders devoted to its incandescent lamps. Attention is called to the fact that each lamp sent out is thoroughly tested before being shipped.

ELECTRIC CRANES.—The constructive details of electric traveling cranes are well illustrated in catalog No. 25 of the Northern Engineering Works, Detroit, Mich. The catalog contains numerous illustrations showing industrial establishments in which the various types of traveling cranes are employed.

FRICTION CLUTCHES.—The Carlyle Johnson Machine Company, Manchester, Conn., has issued a handsome catalog devoted to Johnson friction clutches. Especial mention is made of clutches for cut-off coupling work in connection with marine motors, for which a one-way clutch is particularly adapted.

WATT-HOUR METERS.—In bulletin No. 131 of the Federal Sign System, 205 La Salle Street, Chicago, Ill., a complete description is given of the Willis "straight-line" watt-hour meter. This instrument is a direct-reading meter which can be used for either direct current or alternating current without readjustment or recalibration.

PRINTING ATTACHMENT.—The Minerallic Electric Company, 1004 West Van Buren Street, Chicago, Ill., has issued a new bulletin (No. 25) describing its portable printing attachment as well as the contact-making clock used in connection with it and several features recently added to the company's standard printing attachment.

FITTINGS FOR VACUUM CLEANERS.—The Keller Manufacturing Company, Philadelphia, Pa., has had printed for distribution a sheet containing outline illustrations of standard pipe fittings that may be used with vacuum cleaner pipe installations. While these fittings are standard, many are not used in ordinary piping work, and the trade names of the fittings are given in order to facilitate ordering the same.

LIGHTING SPECIALTIES.—The McGill Manufacturing Company, 36 Oak Street, Valparaiso, Ind., has issued a handsome catalog dealing with lamp guards, portable lamps, soldering specialties, etc. Among the new devices described is a reflector-guard which performs the double service of protecting lamps and reflecting light to any desired point. There is also shown a special metal cone shade for use in connection with wire guards.

ELECTRIC PYROMETERS.—Bulletin No. 130, of the Bristol Company, Waterbury, Conn., is a fifty-six-page illustrated catalog of electric pyrometers, and includes description and lists of both indicating and recording forms of such pyrometers, with explanation of the special patented features, as for instance, basic patents on means of compensating readings of thermoelectric pyrometers for changes in cold-end temperature. On pages 48 to 55 a list is given of more than 700 users of the Bristol pyrometers.

ELECTRIC MINE LOCOMOTIVES.—The General Electric Company has issued Bulletin No. 4790, illustrating and describing in considerable detail two-motor and three-motor mine locomotives of various ratings, arranged to operate either singly or in tandem. The bulletin describes also the gathering locomotive, which consists of a standard locomotive equipped with a motor-operated reel, to which is attached a flexible heavy insulated cable. The gathering locomotive can, therefore, be operated for some distance beyond the terminal of the trolley wire by merely slipping a hook fastened to one end of the cable over the trolley wire. The reel operates automatically and the locomotive is operated in the same manner as when the trolley is used.

ELECTRICAL HOUSE GOODS.—House Goods Bulletin No. 9550, just issued by the Western Electric Company, lists in an attractive manner apparatus, appliances, tools and devices intended for everyday household use. Inter-phones for residences and office service, for private line telephone systems and for apartment house and vestibule use, all of Western Electric manufacture, are listed in many varieties. The booklet contains information and prices on telephone arms and brackets, annunciators, dry batteries, Edison cells, "Hawthorn" bell-ringing transformers, battery supplies, pocket electrical instruments, bells and buzzers of many types, including the "Hawthorn"; burglar alarms, door and window springs and door openers, fire-alarm boxes and annunciators; electric heating devices, including irons, tea kettles, percolators, toasters, chafing dishes, water heaters, air heaters, warming pads and curling iron heaters; "Sunbeam" Mazda lamps, miniature lamps, Christmas tree outfits, Holophane reflectors, portable lamps for a variety of uses, "Hawthorn" Mazdaliers, including the folding type; lamp cords, sockets and receptacles, pendent switches, plugs and current taps, tubular flashlights and vest-pocket flashlights, time switches and door switches; household medical apparatus, including medical batteries, "Hawthorn" electrical massage vibrators and applicators; "Hawthorn" small power motors, sewing machine motors, buffing and grinding machines, washing machines and suction sweepers; "Hawthorn" desk and bracket fans, oscillating fans, ceiling fans and fan motor outfits; push buttons of cast bronze and stamped metal; "Hawthorn" floor treads, speaking tubes, whistles and mouthpieces; switches, telegraph apparatus, relays, arresters, toy battery motors, electrical toy outfits, "Hawthorn" watchmen's time detectors, wireless apparatus; high-tension insulators, "Hawthorn" incandescent lamp cord, call bell outfits, electric window tappers, electric alarm clocks, etc.

BUSINESS NOTES.

THE CENTURY ELECTRIC COMPANY, St. Louis, has appointed Mr. Gus Sachs, 1810 Main Street, Dallas, Tex., as its sales agent for the State of Texas. Mr. Sachs is very well known in that territory, which is also true of the "Century" motors which he will handle.

THE HOYT ELECTRICAL INSTRUMENT COMPANY has found it advisable to close the sales office it has maintained at 161 Summer Street, Boston, Mass. Communications for the company should therefore be sent either to the New York office, 136 Liberty Street, or to the factory at Penacook, N. H.

STERNOID.—The Underwriters' Laboratories, Chicago, have approved "sternoid," made by the Dickinson Manufacturing Company, Springfield, Mass., as "a molding material having suitable non-absorption, non-combustible and insulating qualities, for use in electrical fittings where considerable mechanical strength and durability are required."

RAILROAD STORAGE-BATTERY ORDER.—The Harriman Lines have recently closed a standardization contract with the Willard Storage Battery Company, of Cleveland, Ohio, for their requirements of train-lighting batteries. This contract was awarded to the Willard Company after a thorough service test of all makes of storage batteries extending over a period of two years.

COLUMBIA INCANDESCENT LAMP COMPANY.—The branch office of the Columbia Incandescent Lamp Company in Dallas, Tex., has recently removed from the Prætorian Building to 713 Elm Street. The change was made in order that the office might be located in the same building with the wareroom, thereby enabling the company to handle stock shipments with the greatest dispatch.

W. N. MATTHEWS & BROTHER, EASTERN OFFICE.—Mr. Victor L. Crawford has been appointed Eastern representative of W. N. Matthews, with offices in the Glackner Building, 227 Fulton Street. Mr. Crawford was for a number of years connected with the St. Louis Union Electric Light & Power Company as contracting agent, and for several years has been with the Matthews company as a representative calling on the trade throughout the country.

MR. GEORGE B. DUSINBERRE has been transferred to the New York office of the American Electric Fuse Company, formerly located at 116 Nassau Street, and now in the Hudson Terminal Buildings, 50 Church Street. Mr. Dusinberre was formerly in charge of the Cleveland office of the company, and takes the place in New York of W. B. McCurdy, who has resigned. In the new quarters a large stock will be carried of telephone protectors, magnet wire, motor starters, controllers, battery charging rheostats and ignition apparatus.

SLOW-SPEED MOTORS.—Directing attention to its alternating-current motors for slow speeds, the Kimble Electric Company, of Chicago, says that it does not attempt to cover a large variety of motor speeds by the use of the same punchings. Special stampings are used for each

speed, and they are designed to utilize the material to best advantage. This construction makes it possible to manufacture low-speed motors of good operating characteristics, high power-factor and efficiency and comparatively low no-load current at moderate prices.

THE KLAXON COMPANY, which has handled the Klaxon and Klaxonet warning signal sales, was succeeded Jan. 1 by the Lovell-McConnell Company, at Newark, N. J. W. O. Turner, who has been manager of the Klaxon Company, becomes secretary of the Lovell-McConnell Company, and will take entire charge of the sales and offices. The Lovell-McConnell Company's plant is housed in a building in many respects the most complete factory in the United States. Under the policy of the Lovell-McConnell Company all 1911 jobbers' contracts include an agreement to maintain sales list prices. This means that even if the jobber bought in thousand lots he could not sell a hundred, or ten, or five Klaxons at any less figure than they could be bought from the factory in the same quantities.

DODGE, DAY & ZIMMERMANN, engineers, of Philadelphia, have added to their organization Messrs. Walter Loring Webb and James M. Kennedy, both well known in the engineering world. Mr. Webb is the author of several engineering textbooks, including "The American Civil Engineer's Pocket-Book," "Economics of Railroad Construction" and "Problems in the Use and Adjustment of Engineering Instruments." As pioneers in the field of industrial engineering, Dodge, Day & Zimmermann have been prominent factors in advancing efficiency in industrial and public service enterprises. The principles of which they are exponents have received material impetus of late through the prominence given the subject of efficiency in the recent hearings before the Interstate Commerce Commission on the application of the railroads to increase freight rates.

DIRECTORY OF ELECTRICAL ASSOCIATIONS, SOCIETIES, ETC.

Alabama Light & Traction Association. Secretary, Geo. S. Emery, 11 N. Royal St., Mobile, Ala.

American Electrochemical Society. Secretary, Prof. J. W. Richards, Lehigh University, South Bethlehem, Pa. Next semi-annual meeting, New York City, April or May, 1911.

American Electro-Therapeutic Association. Secretary, Dr. J. Willard Travell, 27 East 11th St., New York. Next meeting at Philadelphia, Pa., Sept. 5, 6 and 7, 1911.

American Institute of Electrical Engineers. Secretary, Ralph W. Pope, Engineering Societies Building, 33 West 39th St., New York. Meetings, second Friday of each month, excepting June, July, August and September.

American Electric Railway Accountants' Association. Secretary, H. E. Weeks, Davenport, Ia.

American Street & Interurban Railway Engineering Association. Secretary, Norman Litchfield, Interborough Rapid Transit Company, New York.

American Street & Interurban Railway Association. Secretary, H. C. Donecker, Engineering Societies Building, 29 West 39th St. New York.

Arkansas Association of Public Utility Operators. Secretary, J. E. Cowles, Little Rock, Ark.

Association of Iron and Steel Electrical Engineers. Secretary, John Farrington, Steubenville, O.

Association of Railway Telegraph Superintendents. Secretary, P. W. Drew, 135 Adams St., Chicago. Next meeting, Boston, Mass., June, 1911.

Association of Railway Electrical Engineers. Secretary, J. Andreucetti, Chicago & Northwestern Railway, Chicago. Next annual meeting, Chicago, November, 1911. Semi-annual meeting, Washington, 1911.

Association of Edison Illuminating Companies. Secretary, N. T. Wilcox, Lowell, Mass.

Canadian Electrical Association. Secretary, T. S. Young, 220 King St. West, Toronto, Can.

Canadian Street Railway Association. Secretary, Allen H. Royce, 48 King St. West, Toronto, Ont.

Central Electric Railway Association. Secretary, A. L. Neereamer, Indianapolis, Ind. Annual meeting at Claypool Hotel, Indianapolis, Ind., Jan. 19, 1911.

Colorado Electric Light, Power & Railway Association. Acting Secretary, F. D. Morris, 323 Hagerman Building, Colorado Springs, Col.

Eastern States Independent Telephone Association of Pennsylvania, New Jersey, Maryland and Delaware. Secretary, H. E. Bradley, 135 South Second St., Philadelphia, Pa.

Electric Vehicle Association of America. Secretary, Harvey Robinson, 124 West 42d St., New York.

Electric Club, Chicago. Secretary, F. S. Hickok, 824 Marquette Building, Chicago. Meets every Wednesday noon, 303 Wabash Ave.

Electrical Contractors' Association of New York State. Secretary, Geo. W. Russell, Jr., 25 West 42d St., New York. Next meeting, Albany, N. Y., Jan. 17, 1911.

Electric Trades Association of Philadelphia. Secretary, J. W. Crum, 1324 Land Title Building, Philadelphia, Pa. Meetings, second and fourth Thursday of each month.

Electrical Contractors' Association of State of Missouri. Secretary, Ernest S. Cowie, 1413 Grand Ave., Kansas City, Mo.

Electrical Salesmen's Association. Secretary, Francis Raymond, 125 Michigan Ave., Chicago. Annual meeting, Chicago, January, each year.

Electrical Trades Association of Canada. Secretary, William R. Staveley, Royal Insurance Building, Montreal, Can.

Electrical Credit Association of Chicago. Secretary, Frederic P. Vose, Marquette Building, Chicago.

Electrical Trades Association of the Pacific Coast. Secretary, Albert H. Elliott, Harding Building, 34 Ellis St., San Francisco, Cal. Monthly meeting, San Francisco, second Thursday of each month.

Electrical Trades Society of New York (Member National Electrical Credit Association). Secretary, Franz Neilson, 80 Wall St., New York. Board of directors meets second Thursday of each month.

Empire State Gas & Electric Association. Secretary, Charles H. B. Chapin, Engineering Societies Building, 29 West 39th St., New York.

Engine Builders' Association of the United States. Secretary, C. H. Lembower, Reading, Pa.

Florida Electric Light & Power Association. Secretary, H. C. Adams, West Palm Beach, Fla. Next meeting, Jacksonville, Fla., April 4 and 5, 1911.

Illinois State Electrical Association. Secretary, H. E. Chubbuck, Peoria, Ill.

Illuminating Engineering Society. Secretary, P. S. Millar, Engineering Societies Building, 29 West 39th St., New York. Sections in New York, New England, Philadelphia and Chicago. Annual convention, Chicago, 1911.

Independent Electrical Contractors' Association of Greater New York. Secretary, L. H. Woods, 2355 Jerome Ave., New York.

Indiana Electric Light Association. Secretary, J. V. Zartman, Indianapolis, Ind.

Internal Combustion Engine Association. Secretary, Chas. Kratch, 416 W. Indiana St., Chicago. Meetings, second Friday of each month.

International Association of Municipal Electricians. Secretary, C. R. George, Houston, Tex. Next meeting, St. Paul, Minn., 1911.

International Electrotechnical Commission (international body representing various national electrical engineering societies contributing to its support). Secretary, C. le Maistre, 28 Victoria St., Westminster, London, S. W., England.

Iowa Electrical Association. Secretary, W. N. Keiser, Dubuque, Ia. Next meeting, Davenport, Ia., April 19, 20 and 21, 1911.

Iowa Street & Interurban Association. Secretary, L. D. Mathes, Dubuque, Ia. Next meeting, Davenport, Ia., April, 1911.

Kansas Gas, Water & Electric Light Association. Secretary, James D. Nicholson, Newton, Kan. Next meeting, Independence, Kan., Sept. 21 and 22, 1911.

Maine Electrical Association. Secretary, Walter S. Hyman, Waterville, Maine.

Massachusetts Street Railway Association. Secretary, Charles S. Clark, 70 Kilby St., Boston, Mass. Meets second Wednesday of each month, except July and August.

Michigan Electric Association. Secretary, Herbert Silvester, Detroit, Mich.

Minnesota Electrical Association. Secretary, T. C. Gordon, Little Falls, Minn.

Mississippi Electric Association. Secretary, A. H. Jones, McComb City Light and Power Co., McComb City, Miss.

Missouri Electric, Gas, Street Railway & Water Association. Secretary, N. J. Cunningham. Next meeting, St. Louis, April, 1911.

National Arm, Pit & Bracket Association. Secretary, J. B. Magers, Madison, Ind.

National District Heating Association. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association, New England Section. Secretary-Treasurer, L. D. Gibbs, 39 Boylston Street, Boston, Mass.

National Electric Light Association, Pennsylvania Section. Secretary-Treasurer, Van Dusen Rickert, Pottsville, Pa.

National Electric Light Association, Nebraska Section. Secretary-Treasurer, S. J. Bell, David City, Neb.

National Electric Light Association, Georgia Section. Secretary-Treasurer, H. M. Corse, Columbus Railroad Company, Columbus, Ga.

National Electric Contractors' Association of the United States. Secretary, W. H. Morton, 41 Martin Building, Utica, N. Y. Next meeting, Niagara Falls, July 19, 1911.

National Electric Light Association. Executive Secretary, T. C. Martin, Engineering Societies Building, 33 West 39th St., New York.

NATIONAL ELECTRICAL INSPECTORS' ASSOCIATION. Secretary, T. H. Day, 27 Pliny St., Hartford, Conn. Next meeting, New York, March, 1911.

NATIONAL ELECTRICAL CREDIT ASSOCIATION. Secretary, Frederic P. Vose, 343 Marquette Building, Chicago.

NATIONAL INDEPENDENT TELEPHONE ASSOCIATION. Secretary, A. C. Davis.

NEBRASKA ELECTRICAL ASSOCIATION. Secretary, Frank McMaster, Beatrice, Neb.

NEW ENGLAND STREET RAILWAY CLUB. Secretary, John J. Lane, 12 Pearl St., Boston, Mass. Meets last Thursday of each month.

NEW ENGLAND ELECTRICAL TRADES ASSOCIATION. Secretary, Alton F. Tupper, 84 State St., Boston, Mass. Directors meet first Wednesday of each month.

NEW ORLEANS ELECTRICAL CONTRACTORS' ASSOCIATION. Secretary, I. G. Marks, 312 Carondelet St., New Orleans, La. Meetings, second and fourth Tuesdays of each month.

NEW YORK ELECTRICAL SOCIETY. Secretary, G. H. Guy, Engineering Societies Building, 33 West 39th St., New York.

NORTHWEST ELECTRIC LIGHT & POWER ASSOCIATION. Secretary, N. W. Brockett, Cataract Building, Seattle, Wash.

OHIO ELECTRIC LIGHT ASSOCIATION. Secretary, D. L. Gaskill, Greenville, Ohio.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL & STEAM ENGINEERS. Secretary, Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio. Next meeting at Youngstown, May 18 and 19, 1911.

OKLAHOMA PUBLIC UTILITIES ASSOCIATION. Secretary, Galen Crow, Guthrie, Okla.

ORDER OF REJUVENATED SONS OF JOVE. Mercury (Secretary), R. M. Van Vleet, 1157 Monadnock Building, Chicago, Ill.

PACIFIC COAST ELECTRIC VEHICLE ASSOCIATION. Secretary, A. H. Halloran, 604 Mission St., San Francisco, Cal.

PENNSYLVANIA ELECTRIC ASSOCIATION. Secretary-Treasurer, Van Dusen Rickert, Pottsville, Pa.

PENNSYLVANIA STREET RAILWAY ASSOCIATION. Secretary, Charles H. Smith, Lebanon, Pa.

PIKE'S PEAK POLYTECHNIC SOCIETY. Secretary, E. A. Sawyer, Colorado Springs, Col. Meetings, second Saturday of each month.

PITTSBURG ELECTRIC BOOSTER CLUB. Recording Wattmeter, O. R. Rombach, 919 Liberty Ave., Pittsburg, Pa. Meetings, fourth Monday of each month.

RAILWAY ELECTRIC SUPPLY MANUFACTURERS' ASSOCIATION. President, A. C. Moore, Safety Car Heating & Lighting Co., Chicago.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Secretary, H. H. Norris, Cornell University, Ithaca, N. Y.

SOCIETY OF WIRELESS TELEGRAPH ENGINEERS. Secretary, E. D. Forbes, Box 63, Brant Rock, Mass. Monthly meeting, first Monday of each month.

SOUTHWEST ELECTRIC & GAS ASSOCIATION. Secretary, E. T. Moore, Dallas, Tex.

STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK. Secretary, C. G. Reel, Kingston, N. Y.

UNDERWRITERS' NATIONAL ELECTRICAL ASSOCIATION. Secretary Electrical Committee, C. M. Goddard, 141 Milk St., Boston, Mass. Next biennial meeting, March, 1911.

VERMONT ELECTRICAL ASSOCIATION. Secretary, A. B. Marsden, Manchester Center, Vt.

WESTERN ASSOCIATION OF ELECTRICAL INSPECTORS. Secretary, W. S. Boyd, 145 Monroe St., Chicago, Ill.

WESTERN SOCIETY OF ENGINEERS. Electrical Section, formerly Chicago Electrical Association. Secretary, J. H. Warder, 1737 Monadnock Block, Chicago. Regular meetings, first Friday of each month, except January, July and August. Annual meeting, first Tuesday after Jan. 1, each year.

WIRELESS INSTITUTE. Secretary, Alfred N. Goldsmith, College of the City of New York, New York.

WISCONSIN ELECTRICAL ASSOCIATION. A consolidation of the Northwestern Electrical Association and the Wisconsin Electric and Interurban Railway Association. Secretary, John S. Allen, Lake Geneva, Wis.

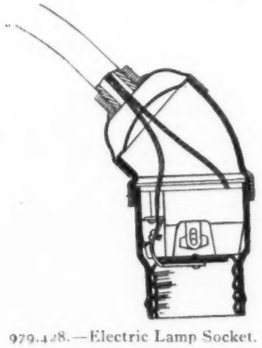
Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED DEC. 26, 1910.

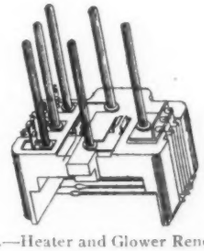
[Conducted by W. F. Bissing, Patent Law, 2 Rector St., N. Y. City.]

13,186. ELECTRIC FURNACE FOR METALLURGICAL PURPOSES; P. Girod, Ugine, France. App. filed Aug. 5, 1909. A refractory hearth, a lower electrode, means for causing part of the metal to unite with the same and an upper electrode in contact with the slag, the lower electrode being partly formed by the metal to be treated and being cooled.

979,404. SELECTING DEVICE; F. G. Agrell, Stockholm, Sweden. App. filed Feb. 27, 1907. For making a large number of connections, by using the armatures of four electromagnets, three of which are in a triangular position and the selector being connected to three armatures by a universal joint so as to give seven positions, with three magnets and fourteen with four.



979,428.—Electric Lamp Socket.



979,455.—Heater and Glower Renewal.

979,428. ELECTRIC-LAMP SOCKET; H. B. Chandler and J. A. Fleet, Portland, Maine. App. filed Aug. 28, 1908. For changing a straight socket into an angle socket by means of an angle piece between the two parts of the socket detachably secured to each part.

979,448. RAIL BOND. R. L. Dunivant, Fort Worth, Tex. App. filed Feb. 7, 1910. Conductors with bond disks carried by the ends of the bond engaging the under surface of the conductors and yielding means holding the disks in engagement with the conductors.

979,455. HEATER AND GLOWER RENEWAL FOR SECOND-CLASS CONDUCTOR LAMPS; O. Foell, A. Kusebauch and R. Neckman, Pittsburgh, Pa. App. filed Nov. 11, 1908. A lamp glower with base for terminals, a heater, a non-conducting support therefor, removably secured to the base for electrically connecting the heater to the terminals.

979,464. LIGHTNING ARRESTER; W. R. Garton, Chicago, Ill. App. filed Nov. 11, 1907. For preventing sneak currents and static discharges by means of separated conductors with an interposed body of a chloride and a capillary element leading from a moisture receptacle into proximity with but insulated from the conductor.

979,465. METHOD OF TREATING CARBON ELECTRODES; W. Gaston, New York, N. Y. App. filed March 9, 1910. Preventing cracking by saturating the hot carbon electrode as it comes from the baking furnace with a thick hydrocarbon solution.

979,467. TELEPHONE MOUTHPIECE; G. W. Gibberd and O. A. Elias, London, Eng. App. filed May 28, 1909. Disinfecting mouthpiece with a screwed sleeve between the mouthpiece and transmitter, radial perforations in the sleeve and an antiseptic ring surrounding the perforations.

979,475. PULL SOCKET FOR ELECTRIC LAMPS; G. W. Goodridge, Bridgeport, Conn. App. filed July 30, 1908. Switch block and spindle with ratchet on the spindle and sliding pawl and returning spring and two spring contacts making a double break.

979,485. ELECTROLYTIC CELL; D. S. Gartshorn, Boston, Mass., and Alan A. Claflin, Medford, Mass. App. filed Sept. 27, 1910. For preventing gas polarizing the electrode, the electrode consisting of a rotary cylinder on a horizontal axis with its circumference partly above, but partly dipping below a liquid electrolyte and a stationary electrode concentric to the cylinder and in proximity therewith beneath the electrolyte.

979,497. MEANS FOR ELECTROLYTIC MANUFACTURE OF SODIUM; P. L. Hulin, Grenoble, France. App. filed Oct. 27, 1908. Cathode consisting of spaced vertical rods hanging below a carrier detachably secured to a fixed support with a cylindrical anode surrounding it.

979,498. COMBINED BRAKE APPARATUS AND SWITCH MECHANISM; W. H. Hultgren, Philadelphia, Pa. App. filed June 21, 1907. For hoisting apparatus for the shipper sheave of an elevator including brakes controlled by the sheave and means for yieldingly holding the sheave in operative position when the brake is released.

979,514. PORTABLE WIRING DEVICE; J. S. Kray, Lancaster, Pa. App. filed Feb. 7, 1910. For stretching and holding wires taut by means of a telescoping standard carrying a head with wedge-shaped top pulleys on opposite sides and frictional gripping arm on the head.

979,515. ELECTRICAL HEATER; F. Kuhn, Detroit, Mich. App. filed Aug. 19, 1909. A receptacle with a hollow member of lesser cross-sectional area than the receptacle and tapering with a tapering sleeve for engaging the hollow member and an electrical heater surrounding the sleeve.

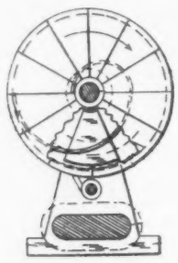
979,544. SHIELD FOR CIRCUIT CONDUCTORS; T. E. Murray, New York, N. Y. App. filed Feb. 2, 1910. The shield is in box form with openings for the pipe carrying the wires and with a removable cover and front wall with means for closing all the holes excepting the pipe hole.

979,556. BLOCK SIGNAL SYSTEM; G. S. Pflasterer, Nashville, Tenn. App. filed Feb. 23, 1909. A three-position signal with an actuating device for moving the signal from danger to an intermediate position and then to a third position with a manual latch preventing movement of the actuating device to set the signal to the third position and an electric lock for the latch.

979,569. TELEPHONE CALL RECORDER; H. K. Sandell, Chicago, Ill. App. filed Sept. 24, 1909. Telephone line with call register which is advanced by the movement of part of the 'phone when making a call, the breaking of a line current rendering the register advancing means effective.

979,570. TELEPHONE CALL RECORDER; H. K. Sandell, Chicago, Ill. App. filed May 23, 1910. Telephone line, call register with advancing means and spring resisting the advance with means for preventing overwinding of the spring, an escapement and an electromagnet operating it to permit the spring to turn back the register.

979,590. TELEPHONE SYSTEM; S. S. Stolp, Chicago, Ill. App. filed Nov. 27, 1908. Bell system for signaling with metallic conductors and grounded battery and grounded signaling devices which are disconnected when the conductors are connected to actuate the signaling device at the opposite ends.



979,603.—Dynamo-Electric Machine.

979,603. DYNAMO-ELECTRIC MACHINERY; D. W. Troy, Montgomery, Ala. App. filed Nov. 1, 1908. A field magnet with a pair of armature conductors movable together through the field, one of the conductors being more inclined than the other and longer than the field, and means for maintaining electrical connection between the conductors at points stationary with respect to the field.

979,608. INCANDESCENT ELECTRIC LAMP SOCKET; S. B. Van Ranst, Syracuse, N. Y. App. filed Oct. 5, 1910. A sleeve terminal, a spring arm fixed outside of the sleeve and extending into it whose free end engages the inner terminal of the lamp.

979,616. TELEPHONE SWITCHBOARD KEY; K. Weman, Buffalo, N. Y. App. filed March 1, 1909. Co-operating contact springs, a key lever having a slot and a separate tip in the slot and engaging the springs, the tip consisting of V-shaped halves.

979,635. ELECTRICITY METER; H. Aron, Charlottenburg, Germany. App. filed April 29, 1909. Bulk limit meter for overloads, including a rotary spindle driven by the current and means for giving it retrograde movement with a coupling for intermittently connecting and disconnecting the means for giving it the retrograde movement.

979,636. ELECTRICAL LAMP WIRE CONNECTIONS; S. Ashdown, Vancouver, B. C., Can. App. filed Jan. 11, 1910. Pendent cords for making more than one connection to the rosette by means of an egg-shaped body with grooves inserted between the wires.

979,637. ELECTRIC MOTOR; C. Backer, New York, N. Y. App. filed April 6, 1910. An electromagnet with oscillating armature connected to the crank of a shaft.

979,651. ELECTRIC CABLE CONNECTION; L. H. Church, Stamford, Conn. App. filed Feb. 3, 1910. A coupling sheath with slotted opening, with a wedge fitting the opening so as to bind a cable within the sheath.

979,652. GAS CONNECTION FOR OUTLET BOXES; L. H. Church, Stamford, Conn. App. filed March 11, 1910. Attaching arms with a central hub and slots in the sides, so that the walls of the hub are closed inward when the attaching arms are pressed downward.

979,663. ELECTRIC FURNACE; B. Guthrie, Pittsburgh, Pa., and J. P. Karch, Plainville, Conn. App. filed March 8, 1909. An electric furnace with a tiltable casing, a crucible therein, electrodes supporting it and means for retracting the electrodes to form an arc.

979,676. SWITCHING SYSTEM; G. T. Lademan, Milwaukee, Wis. App. filed Sept. 2, 1909. Railway telephone, with a substation set, a through line, two terminating lines, a signal receiver on the through line and one on each terminating line and a switch for connecting the substation set to either terminating line and changing the connection of the signal receiver of the selective line to include the local switches and a switch for connecting the set to the through line.

979,712. TROLLEY GUARD AND FINDER; H. R. Sherman, Hartford, Conn. App. filed June 10, 1909. A cradle on a trolley pole movable above the axis of the wheel, with flaring sides to form a trough when the wheel is in contact with the wire.

979,715. ELECTRIC PIANO PLAYER; W. H. Smith, Penge, London, Eng. App. filed Feb. 23, 1909. An automatic operator having an electromagnet, operating a striker with a high resistance in series and a low resistance in parallel and a cut-out in the low resistance, the time of operation of the cut-out with respect to the striker being varied.

979,750. LIFTING MAGNET; A. C. Eastwood, Cleveland, Ohio. App. filed July 17, 1908. For lifting iron and steel, the magnet having a pole piece depending from either end of the core and a magnetizing winding sending its flux through each of the pole pieces and core.

979,769. ELECTRIC SIGNALING BOX; A. Kempston, San Francisco, Cal. App. filed Feb. 23, 1909. Fire alarm for preventing interference of signals by holding a box in a position so that it will start its signal to the main office after another box has completed its round of signaling and thus hold the other boxes till it gets through with its signal.

979,840. INSULATOR BASE; W. T. Goddard, Victor, N. Y. App. filed Sept. 9, 1910. A conical insulator support consisting of two sections connected by a ball and socket joint for universal relative adjustment.

979,856. DEVICE FOR HOLDING KEYS IN FIRE ALARM BOXES; F. B. Holbrook, Rome, Ga. App. filed Aug. 2, 1910. Guard for fire alarm box with posts on the outside and a breakable guard held by the posts and a key having an aperture to receive the guard.

979,860. BONDING FISH PLATE; C. A. Huse, Williamsport, Pa., and James L. Miller, Lewisburg, Pa. App. filed Feb. 18, 1910. A cutting element carried by the rail engaging portion of the fish plate so as to cut into the under part of the thread and the upper part of the base of the rail.

979,868. ELECTRIC RAILWAY BRAKE; J. Mahoney, Wilkinsburg, Pa. App. filed April 20, 1908. The motors are caused to act as generators in braking with means for initially causing a rush of current through the brake and then restoring the brake circuit to normal braking condition.

979,894. ELECTRIC SWITCH; R. D. Snyder, Delta, Pa. App. filed May 12, 1910. A knife switch on a turn table base with a plurality of pairs of contacts arranged around the base.

979,899. LINE THREADING DEVICE; F. N. Steiglederm, Richmond, Va. App. filed March 12, 1910. For threading a cord or line through a pipe, by means of a traveler or piston with a reservoir for compressed air for forcing it through the pipe.

979,904. ELECTRIC SOLDERING IRON; A. H. & C. P. Waage, Chicago, Ill. App. filed Jan. 28, 1910. A heating element or cartridge with a core grooved at one end, a coil surrounding it, terminal wires overlying the groove and an extension from the coil consisting of turns of thin insulation.

979,905. ELECTRIC SEALING DEVICE; J. G. Wallman, Oakland, Cal. App. filed June 27, 1910. For sealing with wax by means of a tube with a cap supporting a seal removably secured to the lower portion of the tube, a casing, a drum in the casing and a current-conductor in the casing encircling the drum.

979,906. ELECTROLYTIC CELL; F. Weinberg, New York, N. Y. App. filed March 31, 1909. Preliminarily immerses an aluminum electrode in a phosphate solution independent of the electrolyte in which the electrode is used and then passes an alternating current through the same until the electrode is formed.

979,912. ELECTRIC IGNITION APPARATUS FOR INTERNAL COMBUSTION ENGINES; F. H. Alston, Birmingham, Eng. App. filed Jan. 24, 1910. Makes use of ball or roller bearing contacts instead of rubbing contacts for the parts of the igniting dynamo.

979,927. ELECTRIC LIGHT RECEPTACLE; H. D. Brown and L. W. Blyyer, Los Angeles, Cal. App. filed Oct. 6, 1909. For metallic signs in which a base has an aperture with notches in the edge, an electric light receptacle of insulating material, a metallic lock having a flange engaging the edges of the aperture for detachably locking by a rotary movement.

979,934. APPARATUS FOR SEPARATING MAGNETIC MATERIALS FROM OTHER MATERIALS OR FROM LIQUORS; A. E. Davis, Birmingham, Eng. App. filed Dec. 28, 1909. A magnetic separator with a tray which is magnetized, a supplemental tray inserted therein, a portion of the bottom of the latter being adapted to be magnetized by induction from the former.

979,940. TROLLEY STAND; C. M. Feist, Sioux City, Ia. App. filed April 13, 1910. A base, a rotatable cap arranged to produce an annular oil well, the top inclosing the bearing portions of the bottom.

979,977. ELECTRIC FIRE ALARM; E. Mahon, Fairfield, Ia. App. filed July 13, 1909. Electric fire alarm and a circuit closer operated by a float in a liquid.

979,986. TELEPHONE RELAY OR REPEATER; H. Morgan, Quinter, Kan. App. filed May 19, 1909. Two magnets with their cores opposite to two other magnets, the first two being supplied with incoming current and the last two supplying outgoing current, the magnets being in a casing and acting as a transformer for repeating.

979,999. APPARATUS FOR THE STERILIZATION OF WATER AND OTHER LIQUIDS; C. S. Piestrak, Paris, France. App. filed Aug. 29, 1910. Sterilizes by ozone, including a liquid inlet tube, a series of cones forming an injector with rings welded to the cones and holding them superposed and two electrodes concentrically arranged, the inner one being exhausted and an air passage between the electrodes communicating with the injector and the atmosphere.

980,024. TELEPHONE RECEIVER; W. H. Thompson, Wheeling, W. Va., and H. R. Stuart, Milwaukee, Wis. App. filed June 11, 1909. For telegraphone with solenoid coil receivers containing a plurality of solenoids with pole pieces extending from the magnet into proximity with each other and co-operating with the solenoids and independently adjustable.

980,032. ROTOR FOR HIGH-SPEED ELECTRICAL MACHINES; H. H. Wait, Chicago, Ill. App. filed March 11, 1907. A central supporting drum, windings around the drum, insulating material compressed outside of the windings, a metallic band compressing the material and a retaining ring around the band.

980,042. TELEPHONE TRANSMITTER; C. Adams-Randall, New York, N. Y. App. filed April 14, 1905. A diaphragm with independent electrodes insulated therefrom engaging electrodes which can be connected in series in whole or in part with a common battery.

980,090. SAFETY APPLIANCE FOR MOTORS; P. R. Forman, Chicago, Ill. App. filed Nov. 23, 1909. For protecting motor windings from undue rushes of current by means of a fuse of large capacity in the motor circuit, an auxiliary fuse of small capacity, also arranged in the motor circuit, a short-circuit for the auxiliary fuse and means operated by current in the motor circuit for breaking said short-circuit.

980,109. MOTOR CONTROL; D. L. Lindquist, Yonkers, N. Y. App. filed May 7, 1908. Alternating-current brake with an alternating motor starter for induction motors, including a speed-controlling device with opposing electromagnets and a brake magnet connected to effect the variation in the strength in one of said magnets.

980,118. TELEGRAPH APPARATUS; J. B. Odell, Chicago, Ill. App. filed Dec. 21, 1907. Selective apparatus for printing telegraphs using a type wheel and ratchet wheel with a shiftable connection between a selecting magnet, an armature, a push and pull pawl pivoted to the armature to feed the ratchet, with means for shifting the connector between the ratchet and wheel to permit the return of the wheel to normal position.

980,129. AUTOMATIC FEEDER REGULATOR; R. P. Rucker, Charlotte, N. C. App. filed April 1, 1910. For regulating the voltage of an alternating-current circuit to be used on single-phase or polyphase circuits, including a regulating transformer with a movable member, a voltmeter with an indicator and arms, one engaging the indicator when the voltage falls below normal and the other when it rises, and connections between the arms and transformers to regulate the voltage of the circuit by actuating the movable member, when one or the other of the arms engages the indicator.

980,153. MAGNETO ELECTRIC GENERATOR; T. S. Hemenway, Buffalo, N. Y. App. filed May 25, 1908. For party lines for ringing Central without ringing the party line signals. The drive shaft for the armature being longitudinally movable and operating a circuit interrupter.

980,156. STEERING MEANS FOR VESSELS; H. Hertzberg and M. J. Wohl, New York, N. Y. App. filed Dec. 12, 1908. Automatically steers and controls the operation by a compass which automatically and momentarily varies the speed of driving a plurality of propellors.